FUNCTIONAL OUTCOME OF ANTERIOR DECOMPRESSION AND FUSION WITH LOCKING CERVICAL PLATE IN SUBAXIAL CERVICAL SPINE INJURIES

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CERTIFICATE

This is to certify that this dissertation in **"FUNCTIONAL OUTCOME OF ANTERIOR DECOMPRESSION AND FUSION WITH LOCKING CERVICAL PLATE IN SUBAXIAL CERVICAL SPINE INJURIES"** is a bonafide work done by **Dr.DHANAGOPAL.M** under my guidance during the period 2010–2013. This has been submitted in partial fulfilment of the award of M.S. Degree in Orthopedic Surgery (Branch–II) by The Tamilnadu Dr.M.G.R. Medical University, Chennai.

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DECLARATION

I, **Dr.DHANAGOPAL.M,** solemnly declare that the dissertation titled **"FUNCTIONAL OUTCOME OF ANTERIOR DECOMPRESSION AND FUSION WITH LOCKING CERVICAL PLATE IN SUBAXIAL CERVICAL SPINE INJURIES"** was done by me at the Rajiv Gandhi Government General Hospital, Chennai-3, during 2010-2013 under the guidance of my unit chief Prof.N.DEEN MOHAMED ISMAIL, M.S(Ortho), D.Ortho.

The dissertation is submitted in partial fulfillment of requirement for the award of M.S. Degree (Branch –II) in Orthopaedic Surgery to The Tamil Nadu Dr.M.G.R. Medical University.

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CONTENTS

INTRODUCTION

Cervical spine injuries are one of the common causes of serious morbidity mortality following trauma.6% of trauma patients have spine injuries of which >50% is contributed by cervical spine injury[10]

Jefferson found that injuries to the cervical spine involve two particular areas: C1-2 and C5-7. Meyer identified C2 and C5 as the two most common levelof cervical spine injury. Injuries of the cervical spine produce neurological deficit in approximately 40% of patients. Approximately 10% of traumatic cord injuries have no obvious radiographic evidence of vertebral injury [5].

Early recognition, immobilisation, preservation of spinal cord function,and stabilisation are the keys to successful management of patients with cervical spine injuries.

Cervical instability due to trauma is usually from the level of C3 to C7 (i.esubaxial).Neurological deficits are not uncommon i.e root compression and cord compression with subluxation and dislocation.

Unstable cervical spine injuries with or without neurological deficit require open reduction stabilisation is done by using various implants and bone grafting.Implants provide immediate stability,whereas bone grafts provide long term stability by achieving intertvertebral fusion.

There is debate in the literature regarding the approach to stabilisation of these fractures, particularly with regard to injuries with disruption of both the anterior and posterior columns. The different approaches that can be used are anterior, posterior, or combined approaches. Halo vests have also been advocated for treatment of these fractures.

Brodke *et al* believe that a fracture involving both columns is an indication to do a combined approach using both anterior and posterior instrumentation[9]. This addresses the biomechanical deficiencies in both columns as well as allowing for anterior decompression. If an anterior or posterior alone fixation is performed, the biomechanical deficiencies are not addressed as only one column is stabilised[11].

A combined surgical approach does have its shortcomings however, such as:

- Increased surgical time
- Increased cost

- The need for the patient to be turned on the operating table
- Increased patient morbidity
- Increased anaesthetic time and complications
- Increased blood loss[13,14]

The advent of locked plate technology has increased the strength and stability of plate osteosynthesis This now lends itself to the possibility of anterior alone plate fixation with postoperative immobilisation in a cervical orthosis[14]. The rationale behind this is that locked plate fixation of the anterior column is sufficient enough to avoid having to augment the posterior column surgically, and simple immobilisation in a Philadelphia collar is adequate. We have done the procedure of anterior decompression and fusion with locking cervical plate for the subaxial cervical spine injuries.

AIM OF THE STUDY

To analyse the Functional outcome of patients treated with "Anterior decompression and fusion with Locking cervical plate in sub axial cervical spine injuries" at Institute of Orthopaedics and Traumatology, Rajiv Gandhi Government General Hospital, Madras Medical College from November 2011 to October 2012.

REVIEW OF LITERATURE

HISTORICAL REVIEW

1550 BC-Egyptian in the Edwin Smith Payrus considered acute neck injury as" ailment not to be treated"[31]

460-377 BC- Hippocrates introduced the methods of traction in prone position for treating spine injuries[31].

1672-Hildanus-First introduce the technique for reducing fracture dislocation of cervical spine[31]

1700-1780-Paul of Agenda suggested surgical excision of fractured spinous process for treating spinal disorders.[31]

1809- Malgaigne said all spinal fractures resulted in paralysis[31]

1856-1904 - Chipault- a French surgeon published the first text book on spinal surgery presenting the most complete survey of past&current spinal surgery[31]

1925-John Davis-first usable lateral radiograph of spine.[31]

1928-Stuckey approached the cervical spine anteriorly for a chordoma.[31]

1929- Taylor introduced head-halter traction.[31]

1958- Cloward the disc-introduced the anterior approach for degenerated disc[31]

1960-Baily&Badgley described the method of anterior cervical fusion of the anterior cervical fusion of cervical of spine using iliac crest graft.[31]

1962-Robinson-Anterior arthrodesis using horse shoe shaped iliac crest graft.[31]

1966-Simmonds-used a keystone shaped graft for anterior cervical fusion [8]

1970-Orosco &Lovet-first to secure a bone chip with a plate, for fractured cervical spine [31]

1986-Caspar plates was introduced.[9]

1990-Orion plates with locking nuts are introduced.

1991-Zdeblick-used freeze dried allograft bone for cervical fusion.[31]

1996-Shapiro used banked fibula and the locked anterior cervical palte for anterior cervical fusion.[31]

1999-Melca-use of bovine (xenograft) with anterior cervical plate for anterior cervical fusion

1999-Majid-used Titanium mesh cages with autografts and anterior plates for anterior arthrodesis.

ANATOMY OF SUBAXIAL CERVICAL SPINE
DEVELOPMENTAL ANATOMY OF CERVICAL SPINE

ANTENATAL DEVELOPMENT

During third week of intrauterine life, development of mesoderm on either side of neural tube and notochord becomes aggregated to form **Somite**s. Somites differentiate into ventromedial part (the sclerotome) and dorsolateral part(the dermatomyeotome). During fourth week,sclerotome forms the vertebra,ribs and the spinal ligaments,while the dermatomyotome forms the musculature and dermis of scalp,neck&trunk.

The cranial half of first cervical sclerotome fuses with the caudal portion of fourth occipital somite to form basilar portion of occipital bone.Caudal half of first cervical sclerotome fuses with cranial half of second cervical sclerotome to form first cervical vertebra.The same type of fusion is repeated down the length of cervical spine.[19]

POST NATAL DEVELOPMENT

Ossification centers in lateral masses that expand into posterior arches join by about 3 years of age.A secondary ossification centre develops in the anterior arch of the cervical vertebra by one year of age.It fuses with the lateral masses by 6 to 9 years.

CLINICAL ANATOMY

Vertebral column is made of 5 parts viz.. cervical, thoracic, lumbar, sacral & coccygeal parts.Cervical spine consists of 7 vertebral,first two of which Atlas&Axis are atypical.C3 to C7 are typical.

TYPICAL CERVICAL VERTEBRA

They are structured to provide limited flexion, extension, tilt and rotation and to provide stability to support the head. Vertebral bodies have a superior surface, which is convex anteroposteriorly and concave laterally.This configuration allows flexion, extension, lateral tilt by gliding movements of facets.Inferior surface of vertebral body is convex.Lateral aspect of body has superior projection called uncinate process.

The lamina and spinous process of C2 vertebra are the largest,whereas C3,C4,&C5 vertebrae have thin lamina and help assume the normal lordotic posture.The spinous processes of third,fourth and fifth cervical vertebra are bifid.The lamina of sixth and seventh cervical vertebra become progressively thickened and larger to approach the size of thoracic vertebra.The facetal joints are placed in acoronal plane angled 45 inclination, lateral tilt is accompanied by rotation and vice versa.The gliding motion of facets allows flexion,extension and lateral tilt.[19]

OSSEOUS STRUCTURES

The osseous constituents of each vertebra and the structure of its articulations with adjacent vertebrae are relatively constant from C3 to C7. Each cervical vertebra consists of an anterior body, from which the pedicles extend posteriorly to meet the lateral masses and lamina, thus forming an osseous canal that envelopes the spinal cord. An important structure arising from the posterolateral corner of the vertebral body's superior surface is the uncinate process, which forms the uncovertebral joint of Luschka with a complementary convexity on the inferior surface of the suprajacent vertebral body. The uncinate process is animportant landmark for defining the lateral boundary of the vertebral body when performing an anterior discectomy or corpectomy.

Extending laterally off the pedicle and anteriorly from the lateral mass are tubercles that form the transverse process, which cradles the nerve root exiting along its superior surface. Within the transverse process is a round defect called the foramen transversarium, through which the vertebral artery ascends, typically by skipping the foramen at C7 and entering at C6.

The lateral mass consists of the superior and inferior articular facets, which, when viewed from the side, give the lateral mass a rhomboid-shaped appearance. When viewed in cross section, the inferior articular facet lies posterior to the superior articular facet of the subjacent vertebrae. This “shingling” configuration can cause confusion when interpreting axial computed tomography (CT) scans.

The laminae extend posteromedially from the lateral masses and converge on the midline to form the spinous process. At C3, C4, C5, and often at C6, the spinous process is bifid. The C7 spinous process is usually the most prominent dorsal structure in the lower cervical spine and, when palpable, represents a useful landmark for making the skin incision for posterior approaches.[19]

NONOSSEOUS STRUCTURES

The most important nonosseous structure of the spinal column is the intervertebral disc. Like that of the lumbar spine, the intervertebral disc consists of a central, gelatinous nucleus pulposus surrounded by the tough, fibrous annulus fibrosus. The disc is bordered superiorly and inferiorly by a cartilaginous end plate, and laterally by the uncovertebral joints. The disc represents an important stabilizing structure for the motion segment.

A number of important ligamentous structures exist within the subaxial cervical spine and also contribute to stability. The anterior and posterior longitudinal ligaments run cephalocaudal along the anterior and posterior aspects of the vertebral body. The ligamentumflavum extends between the laminae. The interspinous and supraspinous ligaments run between the spinous processes and their tips, respectively. Although distinguished in most anatomic textbooks, the interspinous and supraspinousligaments are essentially continuous and form a "nuchal ligament" complex with the ligamentum nuchae.

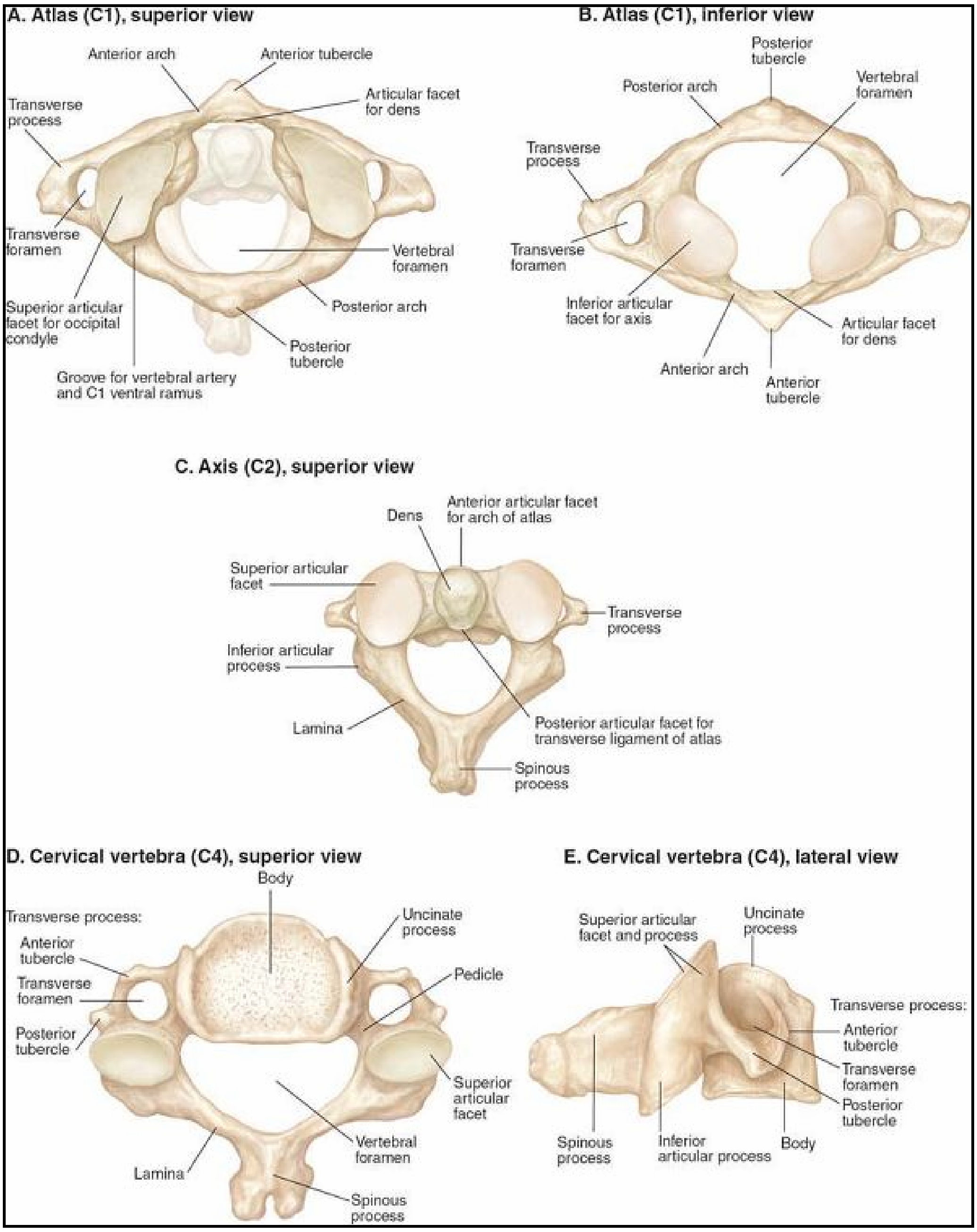

Fig.1 Anatomy of cervical vertebra

THE SPINAL NERVE

Spinal nerve exiting the spinal canal passes through the interpedicular foramen.Laterally in the intertransverse foramen, it divides into two ,a large ventral ramus and a smaller dorsal ramus.The ventral ramus of the cervical spinal nerve courses on the transverse process in the anterolateral direction to form the cervical and brachial plexus.

On the oblique sagittal radiological views,the cervical nerve root is located in the lower part of the interpedicular foramen and occupies the major part of the intertransverse foramen.On the posterior aspect of the lateral mass,the mean distance is about 5.6mm from the posterior centre of the lateral mass to the projection of the spinal nerves superiorly and inferiorly for levels.

THE VERTEBRAL ARTERY

Vertebral artery, a major arterial supply , originates from the subclavianartery,enters the transverse foramen of the sixth vertebra,and courses upward through the foramen above.On the transverse plane,the vertebral artery lies infront of the lateral mass,but is separated by the spinal nerve.[20]

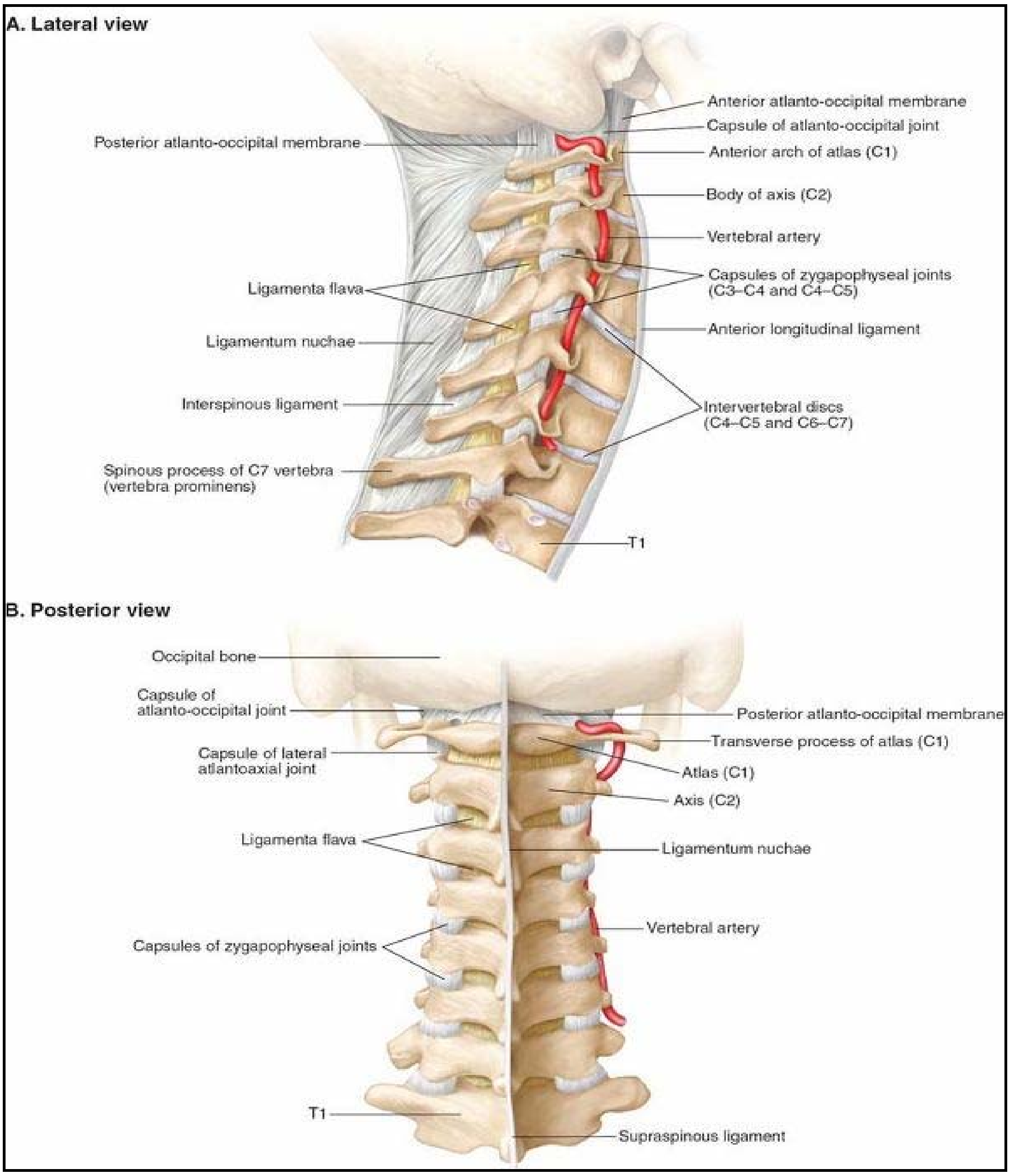

Fig 2 Anatomy of cervical spine

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APPLIED ANATOMY OF ANTERIOR APPROACH TO CERVICAL SPINE

Landmarks in the neck[20]

- Hard palate-arch of Atlas
- Lower border of mandible-C2C3
- Hyoid bone-C3
- Thyroid cartilage-C4C5
- Cricoid cartilage-C6
- Carotid tubercle-C6

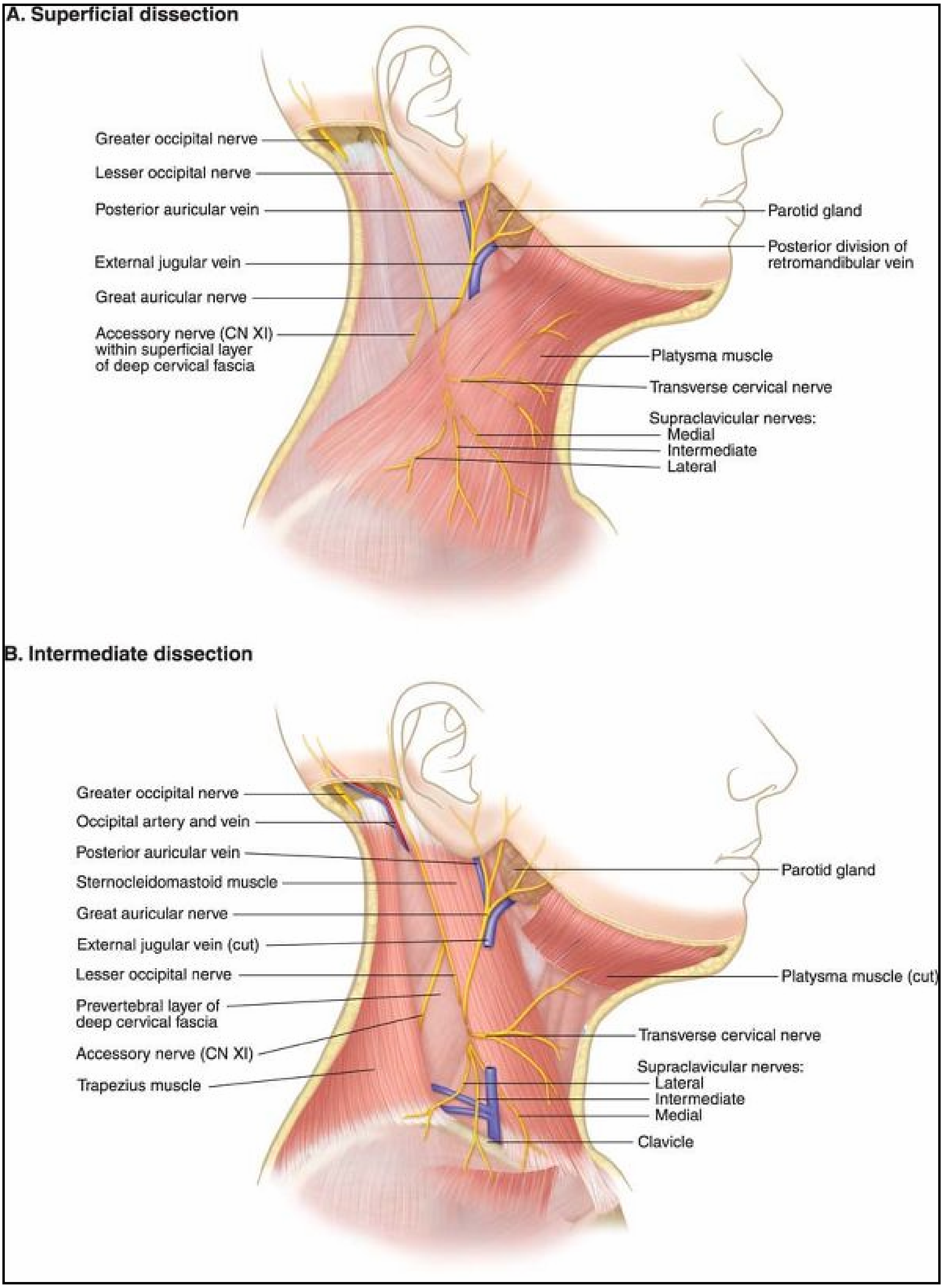


Fig 3 Surgical anatomy of cervical spine

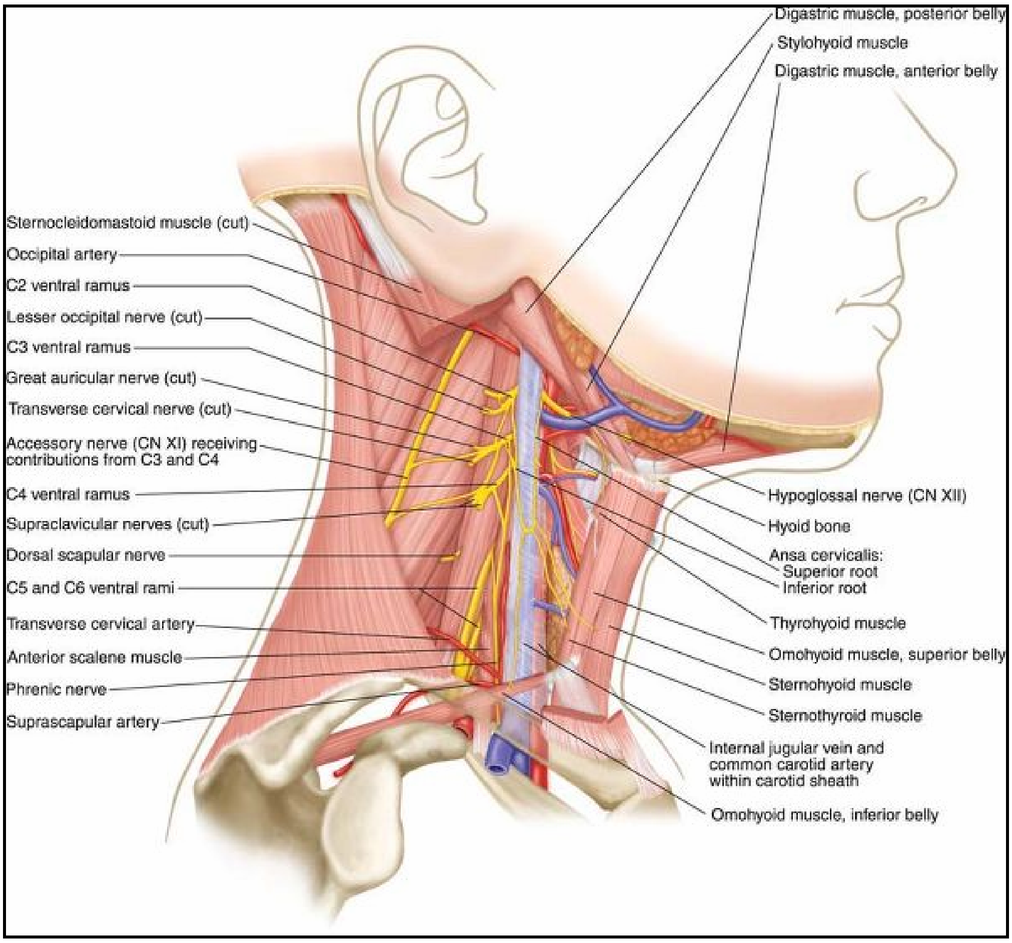


Fig 4 Surgical anatomy of cervical spine

FASCIAL LAYERS IN THE NECK

1) Investing layer of deep cervical fascia-envelops sternocleidomastoid&trepezius muscles.

2) Pretracheal fascia-invests the strap muscles.It is related to the carotid sheath.Superior &inferior thyroid vessels run from the carotid sheath through the pretracheal fascia into midline.These may be divided to enlarge exposure.

3) Prevertebral fascia-It lies in front of prevertebralmuscles,and forms the floor of posterior triangle of neck.

BIOMECHANICAL STABILITY OF THE CERVICAL SPINE
KINEMATICS OF CERVICAL SPINE

In spinal kinematics,the motion is usually described in relation to adjacent vertebra.The secondary coordinate system may be established in the body of adjacent vertebra.

The spine is a mechanical structure.The vertebrae articulate with each other in a controlled manner through a complex of levers(vertebrae), pivots (facets&discspassive restrains(ligaments) and activators (muscles).The major portion of mechanical stability of spine is due to highly developed,dynamic neuromuscular control system.

STRUCTURES ALLOWING MOTION

The subaxial (below C2) spine contributes approximately 50% of flexion-extension and rotation of cervical spine.The orientation of posterior facet joints (45 degree angle in the coronal plane) allows for more mobility than is possible in the other spine regions.Motion at the facet joints is also complemented by concomitant motion between vertebral bodies through the intervertebral discs.Theuncovertebraljoint,notatruediarthrodial joint also contributes to cervical mobility.

STRUCTURES RESISTING COMPRESSION & DISTRACTION

Compressive forces applied in an axial mode are supported or resisted by the vertebral body, the intervertebral disc, theuncovertebral joints of anterior and middle columns,and the facets and lateral masses of posterior column.The is a tripod of support made up primarily of the vertebral body and two lateral masses with associated facet joints.

The ligaments of the cervical spine function primarily to provide resistance to distractive forces.Distraction of the anterior column is limited by anterior ligamentous complex,and posterior column by posterior ligamentous complex.

STRUTURES LIMITING MOTION

Because movement of neck places both compressive and distractive forces on the cervical spine,both bony & ligamentous structures assist in limiting motion.During flexion,compression occurs in anterior column,distraction occurs in posterior column.Flexion is therefore limited by vertebral body,intervertebral disc and posterior ligamentous complex.Likewise extension places compressive forces on posterior column and distractive forces on anterior column.Resistance to extension is therefore provided by lateral mass or facet complex and anterior ligamentous complex.Lateral flexion to one side is limited by contralateral facet capsule and annulus fibrosus and by ipsilateral vertebral body and lateral mass or facet complex.

RANGE OF MOTION

Flexion and extension are free and tends to be greater at C5C6 &C6C7 interspace where they total 17 degree and 16 degree respectively.Lateral bending and rotation are most free at C3C4 &C4C5 levels where they total 11 degree.Neck movements diminishes with age.Forward flexion should normally allow chin to touch the chest.Extension can sometimes allow skull to touch the back.In lateral flexion, ear should touch the shoulder.

In general, the osseous anatomy of the subaxial cervical spine provides little intrinsic stability. This is well demonstrated in cases of severe bilateral facet dislocations, where the soft tissues from the intervertebral disk anteriorly to the capsule ligamentous structures posteriorly have been completely disrupted. Such cases are highly unstable, despite the absence of injury to the osseous structures of the cervical spine. Hence, the nonosseous structures of the subaxial cervical spine, such as the ligaments and intervertebral disks, are important stabilizing structures.[6]

ANATOMIC ELEMENTS OF THE SUB AXIAL CERVICAL SPINE

The anterior elements include the anterior longitudinal ligament (ALL), intervertebral disk, vertebral body, intertransverse ligament, and posterior longitudinal ligament (PLL). The ALL is a multilayered ligament that runs along the anterior aspect of the vertebral bodies and disks, covering the central half of the ventral surface of both. The superficial fibers of the ALL cross multiple levels, and the deeper fibers are associated with a single motion segment. In this ventral position, the ALL and the anterior collagen fibers of the annulus fibrosus are important restraints to extension forces. It is important to recognize that the structure of the cervical intervertebral disk is substantially different from that of its lumbar counterpart. Mercer and Bogduk demonstrated that the cervical annulus fibrosus is thick anteriorly, thins as it approaches the uncinate processes, and is very thin posteriorly.This gives it a crescent-shaped appearance when viewed axially, quite unlike the typical “jelly-donut” appearance of the lumbar disc. In contrast to the lamellar pattern of a lumbar disc, the anterior annular fibers of the cervical disc are vertically and obliquely oriented in an interwoven fashion, akin to an interosseous ligament between the two end plates.This serves as an important restraint to hyperextension, in conjunction with the confluent ALL. Because the anterior annular fibers are shorter and deeper than the multilayered ALL, they fail in extension before the ALL,thus explaining how disruption can occur through the anterior disk without apparent mechanical failure of the ALL. In severe hyperextension injuries, however, the two structures fail together.

Because the posterior annulus fibrosus is thin, it is unlikely to serve as much of a restraint to flexion forces. The PLL, however, covers the floor of the cervical canal and reinforces the posterior annulus. Like the ALL, the PLL is also a multilayered structure, with the deep layers adhering to adjacent vertebral bodies and the superficial layers crossing multiple levels. Throughout the subaxial cervical spine, the PLL is similar to the ALL in terms of its strength and biomechanical properties, and thus is likely to resist bending moments similarly. At each level of the cervical spine, the PLL is slightly wider than the ALL.However, neither the PLL nor the posterior annulus reinforces the region posterior and superior to the uncinate process in the posterolateral corner—an anatomic feature that may predispose to disk protrusions through this area.[19]

POSTERIOR ELEMENTS OF THE SUBAXIAL CERVICAL SPINE

The posterior elements lie posterior to the PLL. These structures include the facets, laminae, and spinous processes, as well as the facet capsules, ligamentumflavum, and spinous processes. The ligamentumflavum runs from the anteroinferior surface of one lamina to the superoposterior surface of its subjacent lamina. At approximately 5 mm in thickness, the ligamentumflavum in the cervical spine is thinner than that of the thoracolumbar spine. Its elastin content gives it both a yellowish appearance and elastic properties that promote extension and restrict flexion. How effectively the ligamentumflavum restrains motion likely changes as it degenerates with age and becomes thicker and stiffer, and it may itself contribute to dorsal spinal cord compression during cervical hyperextension.

The capsules of the facet joints are relatively thin and more patulous than those of the thoracolumbar spine. The capsule bridges the osseous lateral mass on either side of the superior and inferior articular surfaces and is thinnest posteriorly and thickest along its anterolateral region.

In a cadaveric model, Onan and co-workers demonstrated that the subaxial cervical facets were highly mobile, and when the facets were isolated by disconnecting them from the surrounding lamina and vertebral body, the facet capsules by themselves did little to restrict joint motion due to their laxity. In fact, capsular strain was not observed in flexion until the joint had almost dislocated anteriorly. This suggests that the facet capsules act as a posterior restraint to flexion only at the extremes of facet motion and are thus less frequently injured. Panjabi and colleagues supported this notion in simulations of frontal impact, during which the cervical spine rapidly flexes forward when the “torso” decelerates. They found that the capsules (and PLL) rarely experienced significant strain during this injury model and thus are not prone to disruption during accidents involving frontal impact. Although these data may suggest that the capsules contribute little to the stability of the subaxial cervical spine, one should be careful not to disrupt the capsules at the nonfused levels when performing posterior approaches to the cervical spine, as this may lead to subluxation at the level above or below.

The interspinous and supraspinous ligaments run between the spinous processes of each vertebra. They are poorly developed in the cervical spine compared with the thoracolumbar spine. These ligaments are confluent with the ligamentumnuchae, which is a triangular fibrous membrane that extends from the spinous processes to the skin between the external occipital protuberance and the C7 spinous process. The interspinous and supraspinous ligaments are farthest away from the anterior aspect of the spine, and thus they have the longest moment arm to resist bending forces, making them important restraints to flexion. In Panjabi and colleagues' aforementioned frontal impact simulations, the interspinous and supraspinous ligaments were stretched or disrupted most commonly, even at the lowest impact forces tested.The role of the ligamentumnuchae is overlooked in such biomechanical studies because it is typically removed from the cadaveric specimens prior to testing. Takeshita and associates demonstrated that the ligamentumnuchae indeed contributes as a posterior restraint to flexion, as one might expect from its posterior position.Resection of the ligamentumnuchae alone increased the flexion range of the cervical spine by 28 percent. Further resection of the supraspinous, interspinous, and ligamentumflavum increased the flexion range by 52 percent.

INSTABILITY

White and Panjabi defined clinical instability as the "loss of the ability of the spine under physiological loads to maintain relationships between vertebrae in such a way that the spinal cord or nerve roots are not damaged or irritated, and deformity or pain does not develop".[6]. Clinical instability can be defined as any interruption in normal smooth translation of vertebral biomechanics as evidenced by jeky or excessive spinal movements.. Chronic instability is the result of progressive deformity that may cause neurological deterioration, prevent recovery of injured neural tissue, or cause increasing pain or decreasing function.

White, Southwick, and Panjabi suggested that a motion segment should be considered unstable if all the anterior or posterior elements are not functional. They developed a checklist for the diagnosis of clinical instability of the lower cervical spine in which a score of 5 or more indicates instability.

Table 35-6-- Checklist for Diagnosis of Clinical Instability in Lower Cervical Spine[6]

Element	Point Value
Anterior elements destroyed or unable to function	2
Posterior elements destroyed or unable to function	2
Relative sagittal plane translation >3.5 mm	2
Relative sagittal plane rotation > 11 degrees	2
Positive stretch test	2
Medullary (cord) damage	2
Root damage	1
Abnormal disc narrowing	1
Dangerous loading anticipated	1

From White AA, Southwick WO, Panjabi MM: Clinical instability in the lower cervical spine: a review of past and current concepts, Spine 1:15, 1976.

IMPLANTS

Anterior cervical locking plates&screws.

Constrained system-include Orion plates &cervical spine locking plates(CSLP)-locking of plate is possible.

Principles of Locking cervical plate.

1) Stable fixation by screws lock to the plate.

2) Load sharing-follows “Wolf’s law” to allow fusion.

3) Safe and secure construct -Instrumentation supports optimal medial screw angulation

4) Thin plate with smooth profile-minimises tissue irritation

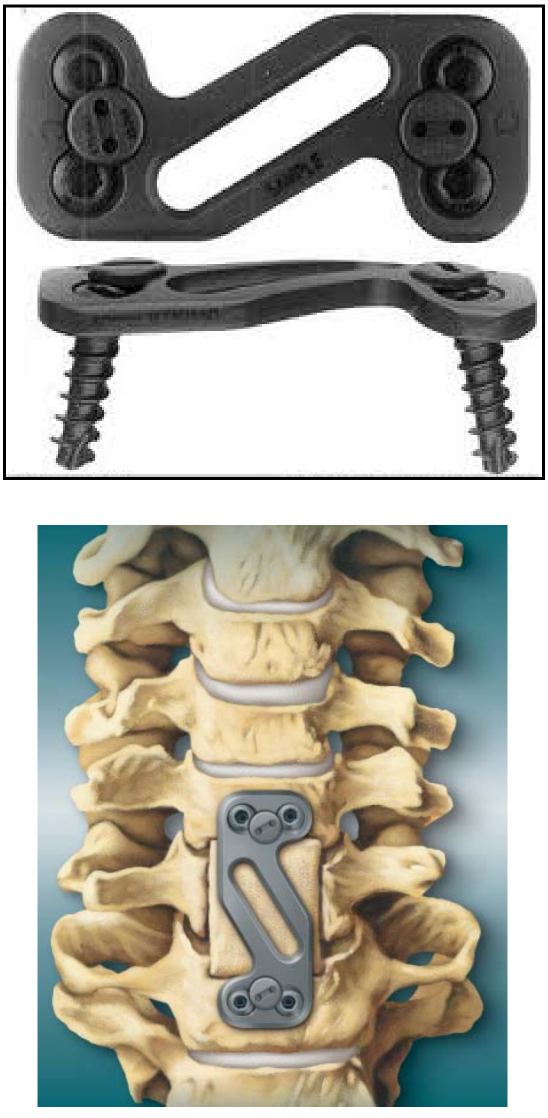


Fig-5: Locking cervical plate

INCISION

The preferred approach for anterior stabilisation of spine is Southwick Robinson approach according to Bailey and Badgely[1],Southwick & Robinson[21],Cloward[1].For cosmetic reasons many authors prefer transverse incision along the Langer's lines.There are various reasons for choosing to operate from the right or left of the patient.The variable course of the recurrent laryngeal nerve on right side and its susceptibility of injury is often given as a rationale for favouring a left sided approach.Recentinvestigations suggest that the nerve may become trapped between the retractor blades and the endotracheal cuff.Momentarily releasing the cuff pressure after retraction allows the nerve to shift its position and avoid injury.Right handed surgeon tend to approach from the right and opposite is true for left handed surgeon.The thoracic duct is unilateral structure on the left side and as such is susceptible to injury only from the left sided approach.Chylothorax is a serious complication that can be avoided with right sided approaches.[21]

CLASSIFICATION

Numerous classifications of cervical spine injuries have been formulated, but the mechanistic classification proposed by Allen et al[5]. Seems to be the most complete. In a review of 165 lower cervical spine injuries, they identified the following six common patterns of injury, each of which is subdivided into stages based on the degree of injury to osseous and ligamentous structures.[6]

COMPRESSIVE FLEXION - FIVE STAGES

Compressive flexion stage 1- Blunting of the anterosuperior vertebral margin

Compressive flexion stage 2- The anteroinferior vertebral body has a "beak" appearance, concavity of the inferior end plate may be increased, and the vertebral body may have a vertical fracture.

Compressive flexion stage 3- Fracture line passing obliquely from the anterior surface of the vertebra through the centrum and extending through the inferior subchondral plate, and a fracture of the beak.

Compressive flexion stage-4 Stage III & posterior translation of upper vertebra measuring <3mm

Compressive flexion stage 5- Posterior translation of upper vertebra measuring >3mm,facet gapping,indicating anterior and posterior ligamentous injury

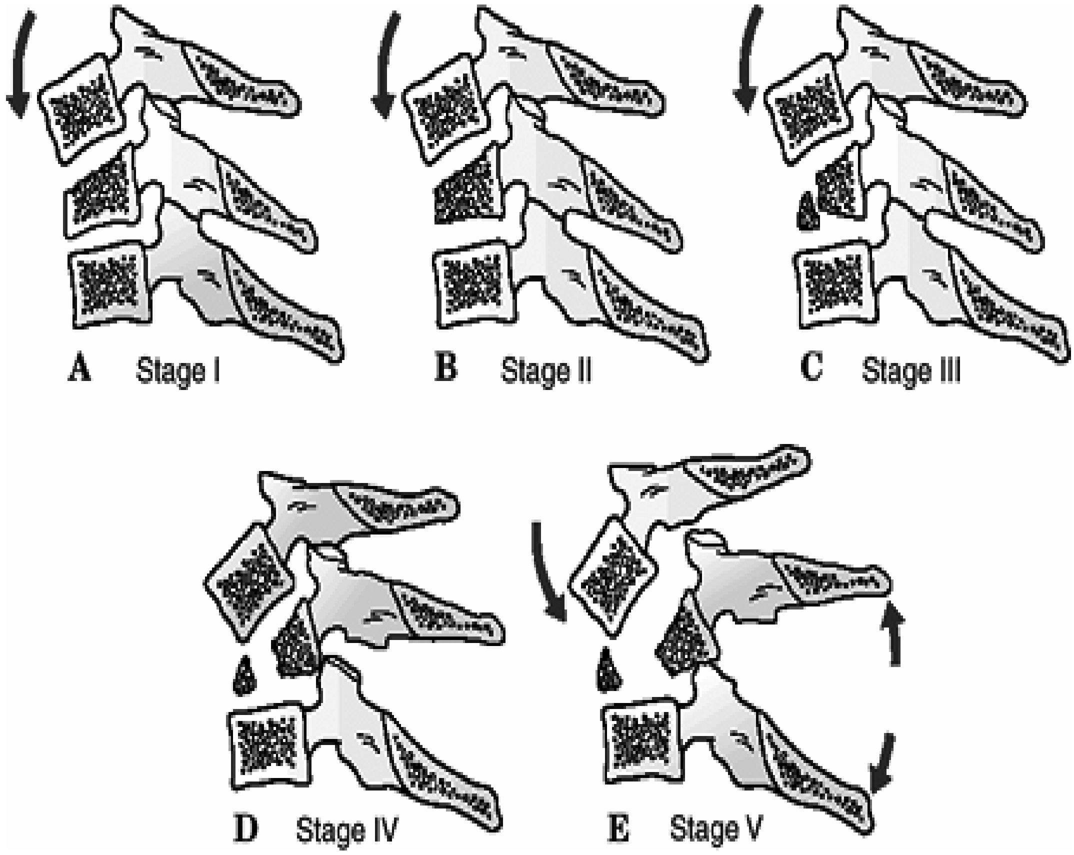


Fig 6 Compressive flexion

VERTICAL COMPRESSION - THREE STAGES

Vertical compression stage 1 - fracture of the superior or inferior end plate with a "cupping" deformity.

Vertical compression stage 2 - fracture of both vertebral end plates with cupping deformities.

Vertical compression stage 3 - Vertebral body communition with or without retropulsion of fragments,with or without kyphotic or translational deformity.

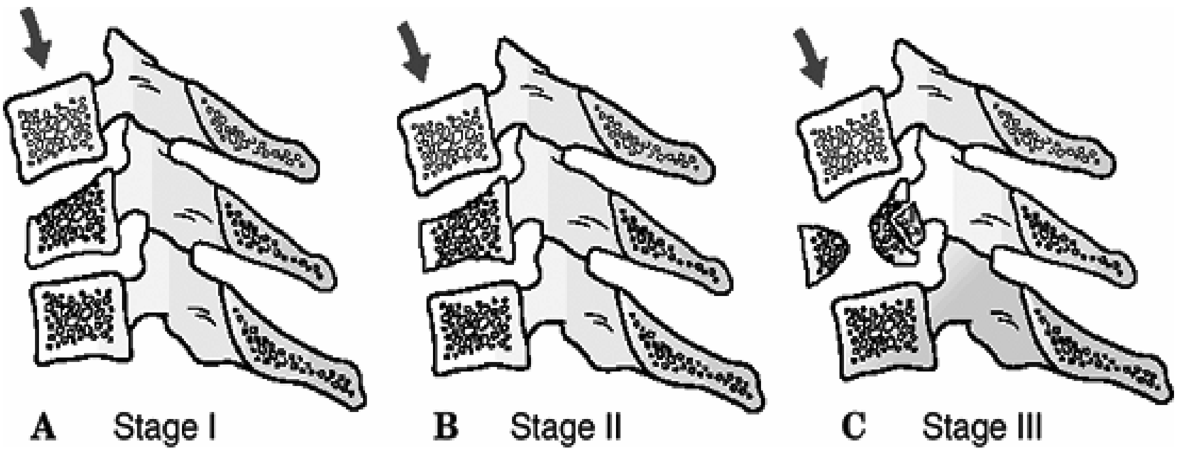


Fig 7 Vertical compression

DISTRACTIVE FLEXION - FOUR STAGES

Distractive flexion stage 1- facet subluxation in flexion, with abnormal divergence of the spinous process.

Distractive flexion stage 2 - unilateral facet dislocation

Distractive flexion stage 3- bilateral facet dislocations, with approximately 50% anterior subluxation of the vertebral body.

Distractive flexion stage 4 - full vertebral body width displacement anteriorly or a grossly unstable motion segment, giving the appearance of a “floating” vertebra.

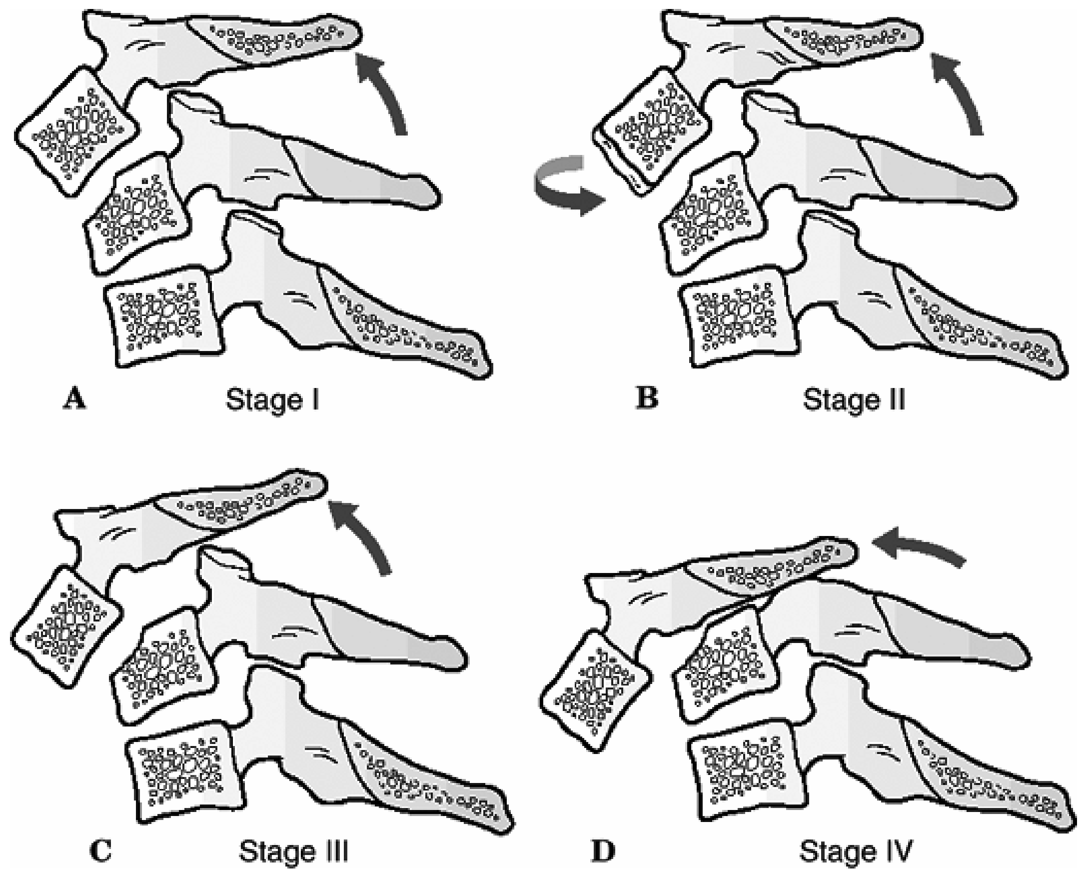


Fig -8 Distractive flexion

COMPRESSIVE EXTENSION - FIVE STAGES

Compressive extension stage 1- unilateral vertebral arch fracture with or without anterior rotatory vertebral displacement

Compressive extension stage 2 - bilaminar fractures without evidence of other tissue failure. Typically, the laminar fractures occur at multiple contiguous levels.

Compressive extension stage 3 - bilateral vertebral arch fractures with fracture of the articular processes, pedicles, lamina, or some bilateral combination, without vertebral body displacement.

Compressive extension stage 4 - bilateral vertebral arch fractures with partial vertebral body width displacement anteriorly.

Compressive extension stage 5 - bilateral vertebral arch fracture with full vertebral body width displacement anteriorly.

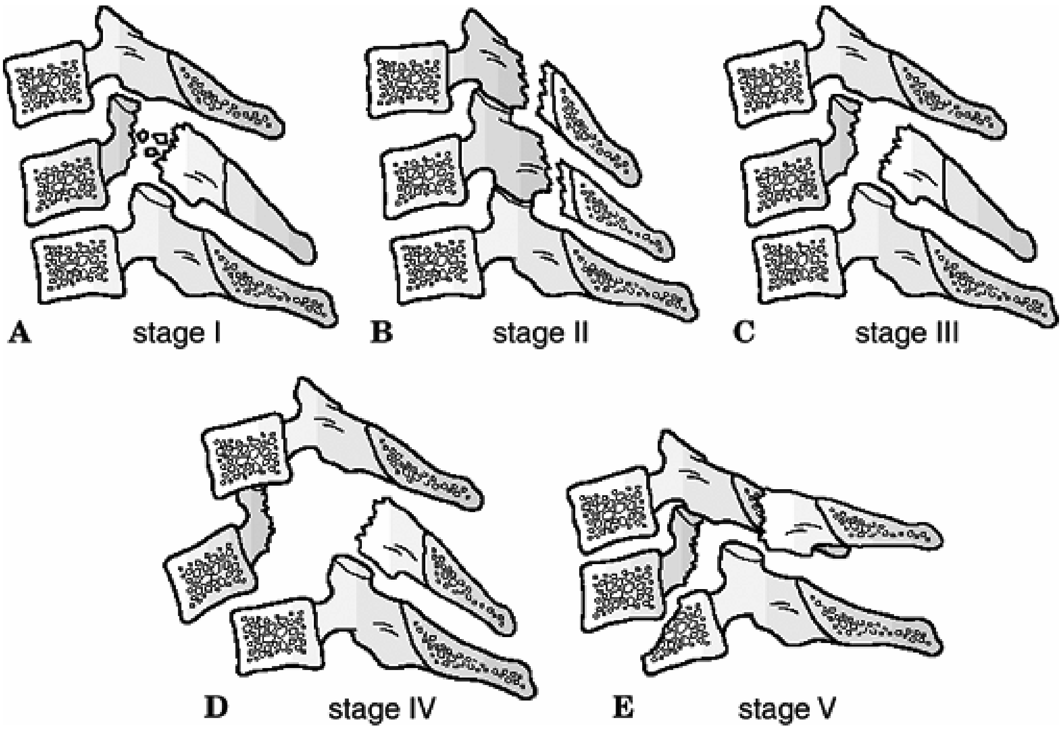


Fig 9 Compressive extension

DISTRACTIVE EXTENSION - TWO STAGES

Distractive extension stage 1- Abnormal widening of anterior disc space

Distractive extension stage 2 - Stage 1 and posterior translation

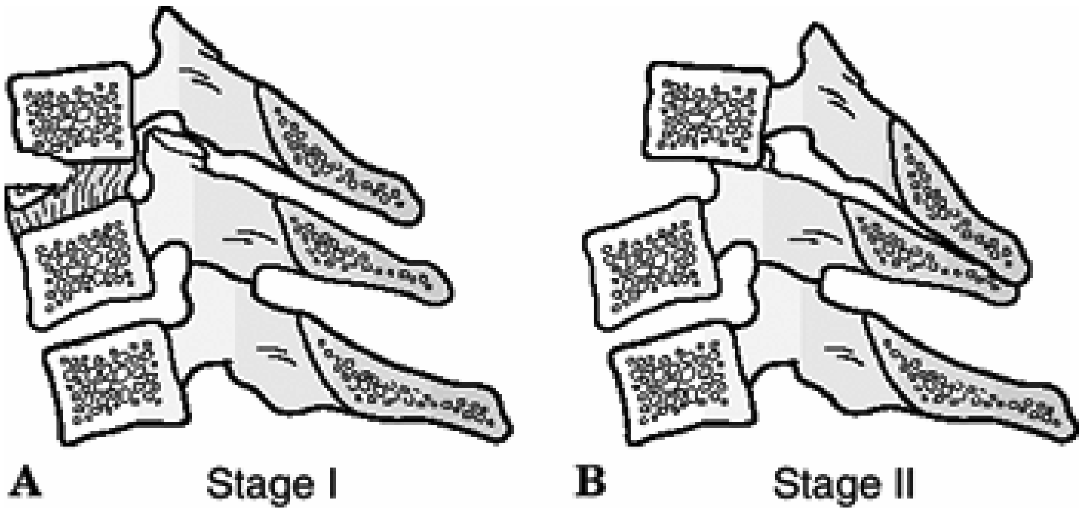


Fig 10 Distractive extension

LATERAL FLEXION - TWO STAGES

Stage I-Unilateral uncovertebral fracture or asymmetric vertebral body compression.

Stage II-Vertebral body or posterior arch fractures with lateral translation or unilateral facet gapping,coronal angular deformity noted on an AP X-ray.

INVESTIGATIONS

The assessment of cervical spine instability begins with basic physical examination .similarly imaging of cervical spine should begin with basic conventional radiography.CT,MRI should be reserved for appropriate radiographic and clinical examination.

RADIOGRAPHY

AP view-Recognised structures include vertebral bodies, superior and inferior end plates, discspaces, uncinateprocesses, which together with the inferolateral aspect of superadjacent vertebral body can be seen.

Lateral view-recognised structures include vertebral body, discspaces, U-shaped transverse process superimposed on the vertebral body.articularmasses, adjacentfacets, interfacetaljoints, lamina and spinous processes.

Pull down lateral view-demonstrates

1) C7T1, apophyseal joints

2) Superior end plates of T1.

3) Anterosuperior aspect of body of T1

4) Cervicothoracic prevertebral soft tissue shadow

Swimmers view- taken in a position of arms similar to the Australian free style swimming stroke position.It gives osseous superimposition & typically seriously obscures visualisation of middle and posterior columns of the C7 vertebra

Right and left oblique view-shows posterolateral aspects of vertebral body,pedicle,and intervertebral foramen.

CT scan-shows the body of the dislocated vertebra anterior the uncinate process and body of the subjacent vertebra and the dislocated anterior masses anterior to the subjacent masses in this configuration,the uncovered superior facets of the subjacent vertebra will be clearly evident

MRI-determines the extent and type of spinal cord injury,presence of other intraspinalpathology,assess ligamentous and disc injury,also assess the status of posterior longitudinal ligament in retropulsion of the disc at the level of injury.

THE GOAL OF TREATMENT OF SPINAL CORD INJURIES

1) Decompress neurological elements.

2) Preserve residual neurologic function and also to improve neurological function.

3) Restore spinal alignment.

4) Restore spinal stability.

MATERIALS AND METHODS

STUDY DESIGN

This is a prospective study of 40 cases of subaxial cervical spine injuries treated at Rajiv Gandhi Government Hospital, Chennai from November 2011 to October 2012.The study was done with clearance from Hospital ethical committee.Informed consent was obtained from all the patients.

INCLUSION CRITERIA

Age more than18 years and less than 60 years.

All subaxial cervical spine injuries including fractures, subluxations, traumatic disc prolapses with more than one column involvement included in this study.

EXCLUSION CRITERIA

Age less than18 and more than 60 years.

Patients with associated injuries.

Patients with severe comorbid conditions

INITIAL MANAGEMENT

1) Management of Airway,Breathing,Circulation

2) Collar immobilisation

3) Fluid and electrolyte management.

4) Assessment of neurological status.

5) Methyl prednisolone succinate if injury is <8 hours old.Dose-30mg/kg in first 15 minutes,followed by 5.4mg/kg/hrI.V infusion for next 23 hours.

6) Skull tong traction .

7) After stabilisation of patient appropriate X-rays,CTscan,MRI was taken.

8) Cervical injuries were classified by using standard classification system i.e Allen Fergueson classification.

9) Patients were assessed and surgical procedure planned.

PROCEDURE

Anaesthesia-General anaesthesia

Position-Supine position

Incision-Transverse incision

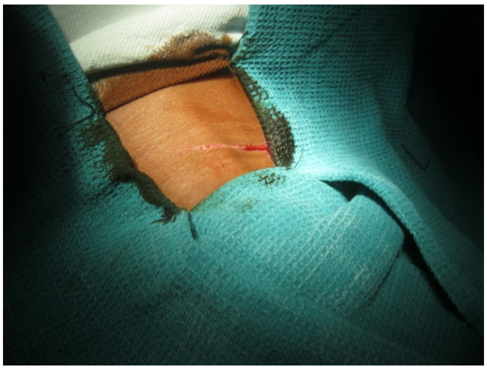


FIG-11: POSITION AND INCISION

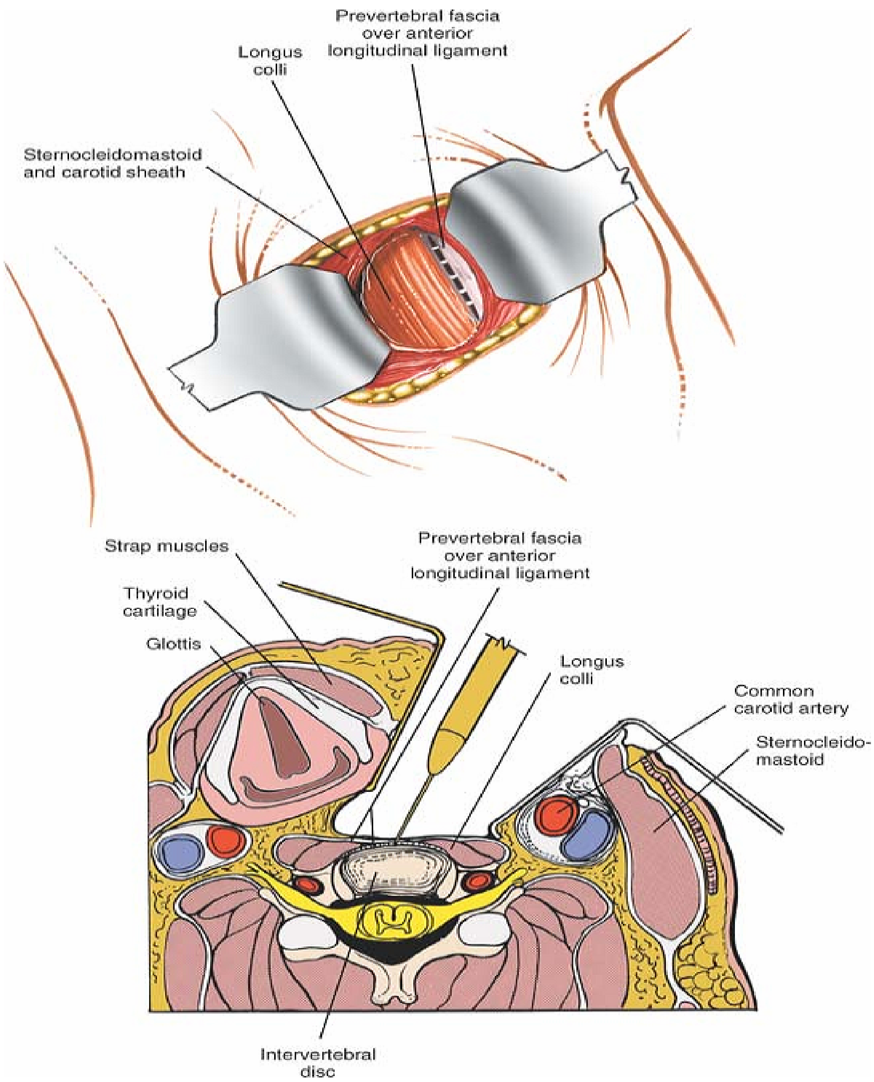


Fig 12 Southwick Robinson approach

Anterior Southwick and Robinson's approach from right side sandbag placed under inter-scapular and ipsilateral iliac regions. Both shoulders were tucked down towards the foot end of table. This position ensures hyperextension and thereby better visualization of the cervical spine intraoperatively. Palpation of thyroid, cricoid cartilage corresponding to C3, C4-C5 and C6 level respectively A standard transverse incision was made. After incising platysma, anterior border of sternocliedomastoid muscle (SCM) was identified. Superficial layer of deep cervical fascia was incised, carotid pulsations were palpated and SCM along with carotid sheath was retracted laterally while trachea, eosophagus and thyroid were retracted medially. Middle layer of deep cervical fascia enclosing omohyoid was incised and omohyoid were retracted cephalad or caudad depending upon the desired level. Deep layers of deep cervical fascia overlying Longus colli muscles were divided bluntly. Longus colli were reflected subperiostealy.

A thin needle doubly bent at 90 degrees was placed in appropriate disc space and lateral radiograph was taken to verify the exact level. Anterior longitudinal ligament and annulus over disc were incised and disc taken out End plates of adjacent bodies and space for graft were prepared. Spaces were packed with gel foam and wound was covered with a clean sponge. For corpectomy the body of vertebra excluding lateral cortices was removed.

A Tricortical graft harvested from iliac crest equal to measured dimensions and was fashioned into a wedge to maintain cervical lordosis .Then the graft is placed either corpectomy or discectomy space. A lateral radiograph was taken to check position of graft. The anterior cortex was drilled by 2.7 mm bit and appropriate size locking plate was placed and screws of 14-16 mm were used .They are directed towards midline at an angle of 6 degrees in a convergent manner & directed 15 degree cranially in cranial hole and 15 degree caudally in caudal hole.

Position of screw was checked with C-arm and then diagonally, opposite locking screw was then placed. Position of screws and plate was again checked with C-arm. After ensuing proper haemostasis, platysma, subcutaneous tissue and skin were closed in layers without drain and a philadelphia collar was applied and patient extubated.

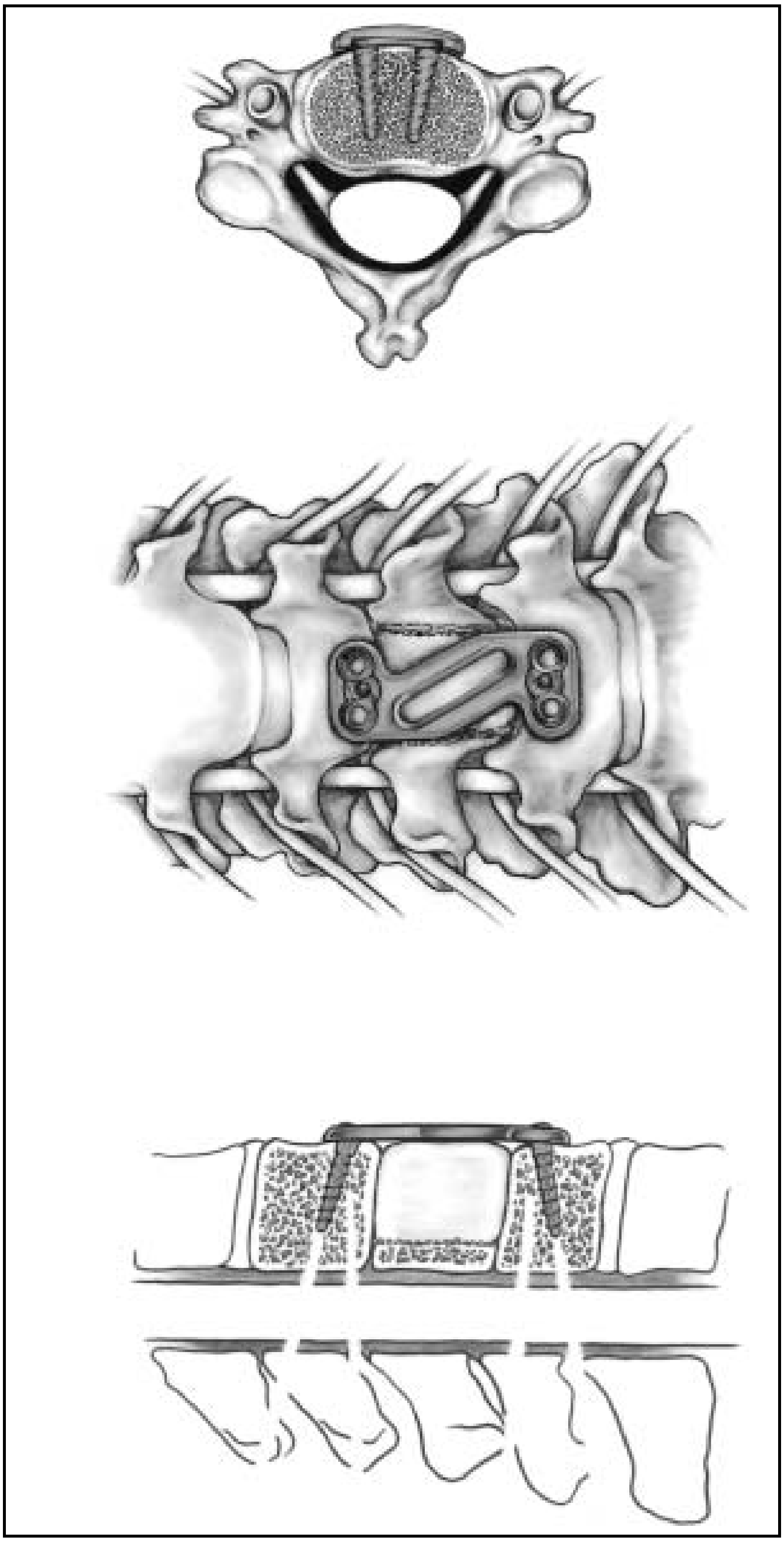


Fig 13 Placement of plate and screw

Fig 14 Intraoperative images showing bone graft in situ

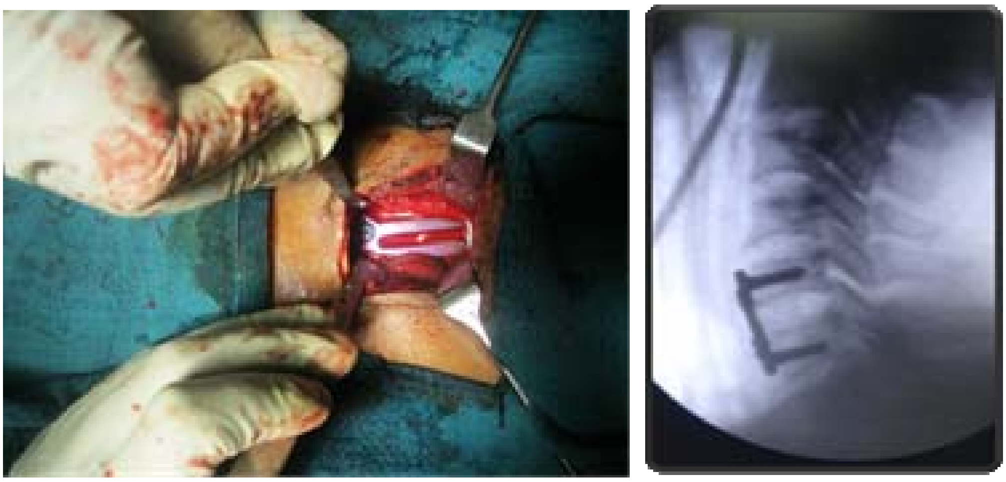


Fig-15: Intra operative image shows plate in situ.C-arm image intensifier

POST OPERATIVE PROTOCOL

1) Patients were allowed take liquid diet on the evening of surgery depending on the neurological status and solids were allowed next day.

2) Post operative X-rays were taken.These patients were allowed to turn horizontally on 1st postoperative day and was allowed to sit upright and assisted to walk with Philadelphia collar on 2nd postoperative day.

3) Intravenous antibiotics were given for 3 days.Oral antibiotics were given for 4 days.

4) Periodic neurological examinations were conducted.

5) Physiotherapy in the form of Active/Passive mobilisation was taught.

6) Bladder, Bowel, Back care was taught.

7) Sutures removed and patients were discharged with collar on 7^{th} postoperative day.

8) The follow-up examinations and X-Rays with the patient reporting at an interval of 1 month for first 3 months and thereafter every 3 months. The final result were analysed on the basis of following criteria:

9) Neurological recovery as per ASIA scale,bone fusion,stability assessment, pain.

OBSERVATIONS

AGE INCIDENCE

Age of the patients ranged from 18 to60 years. Mean age was 38.9years

Age(years)	No.of patients	Percentage
11-20	4	10
21-30.	6	15
31-40	11	27.5
41-50	13	32.5
51-60.	6	15

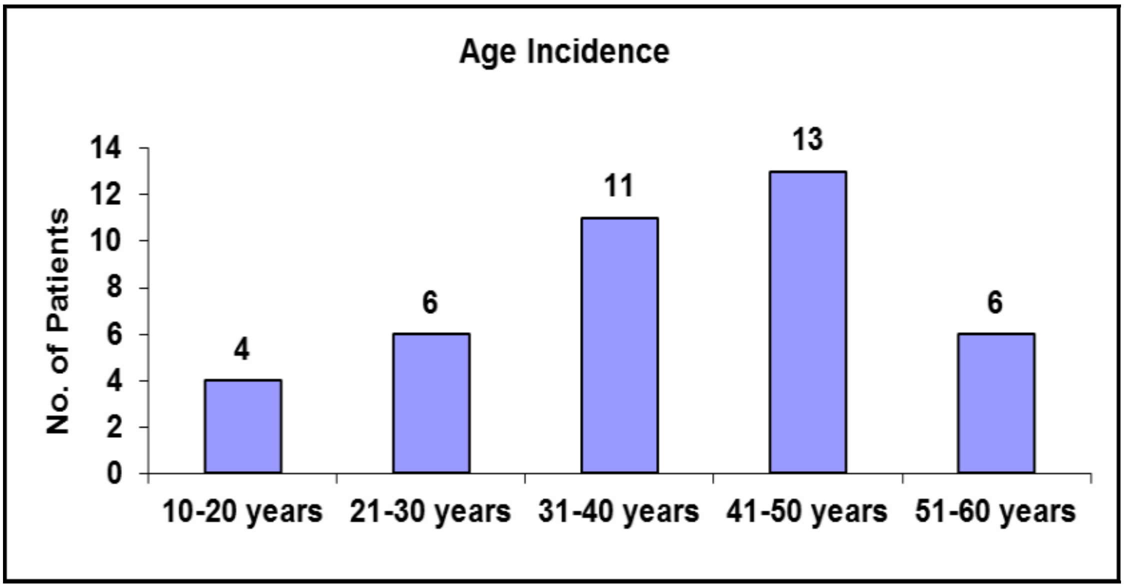


Chart-1: Age incidence

SEX INCIDENCE

Sex	No.of patients	Percentage
Male	35	87.5
Female	5	12.5

Table-1: Sex incidence

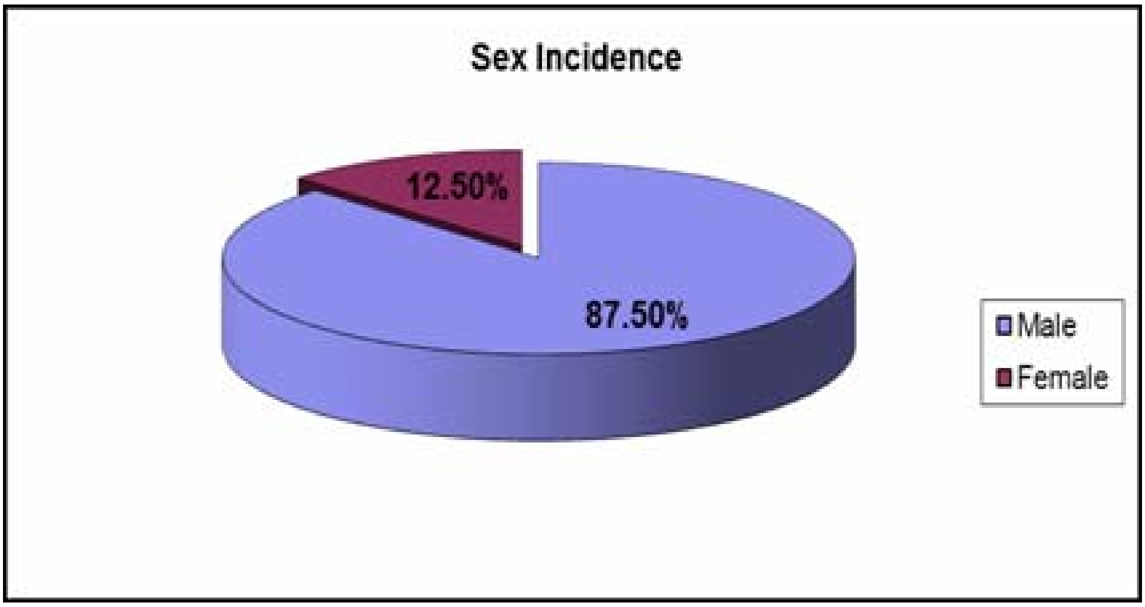


Chart-2: Sex incidence

MODE OF INJURIES

Mode of injury	No. of patients	Percentage
Road traffic accident	18	45
Fall from height	12	30
Fall with weight on back	5	12.5
Slip and fall on level ground	4	10
Sea water diving	1	2.5

Table-3: Mode of injuries

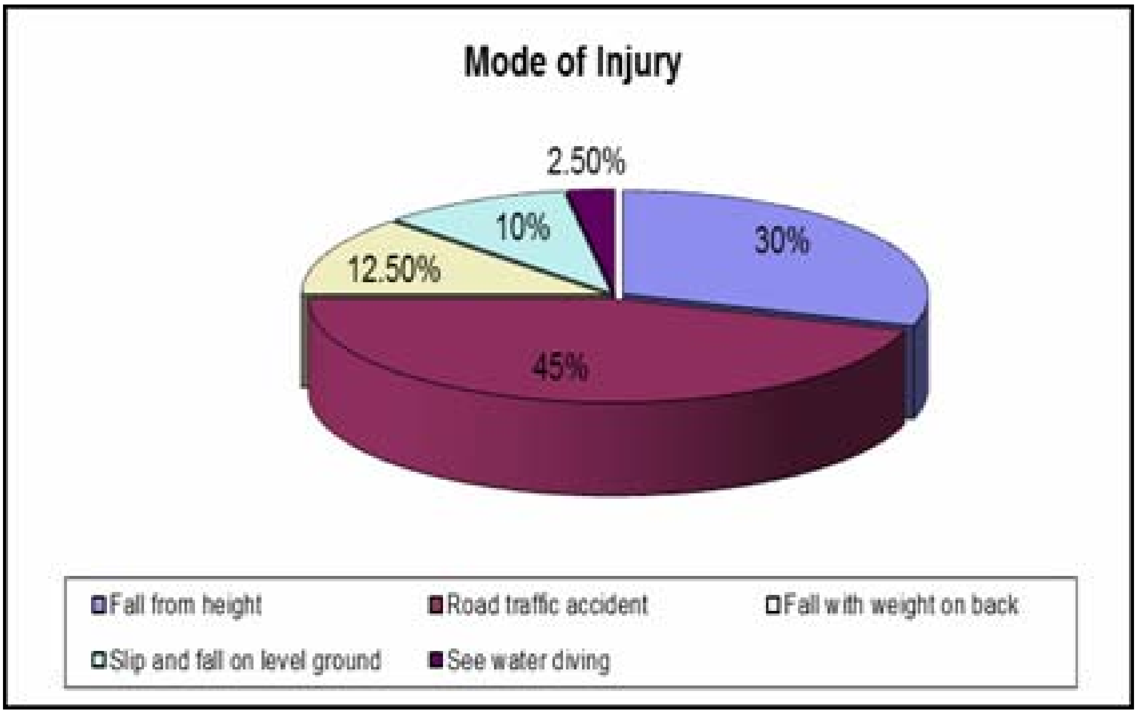


Chart -3: Mode of injury

TYPE OF INJURIES

Type of injury	No.of patients
C6C7 subluxation	5
C5C6 body fracture	2
C5 body fracture with lamina fracturte	4
C5C6 subluxation with disc protrusion	8
Traumatic disc prolapse C3C4,C4C5	1
Traumatic disc prolapse C5C6	5
C4C5 body fracturte	1
C7 body fracture	1
C4C5 traumatic disc prolapse	2
C4C5 subluxation	4
C3C4 subluxation	3
C4 body fracture	2
C6 body fracture	1

Table -4: Type of injuries

CLASSIFICATION

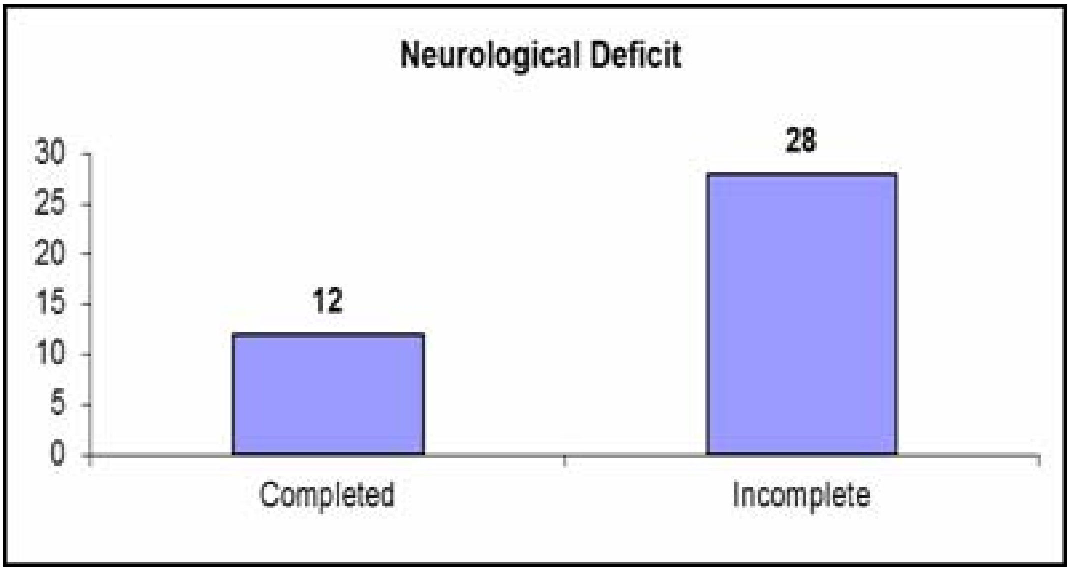
Classification type	No.of patients
Compressive flexion	6
Distractive flexion	13
Vertical compression	12
Traumatic disc bulge	9

Table-5: Classification

NEUROLOGICAL STATUS

Neurological deficit	No.of patients
Complete	12
Incomplete	28

Table-6: Neurological status



Bar diagram - Neurological status

PRE OPERATIVE FRANKELS GRADE

Pre-op frankels grade	No.of patients
A	12
B	2
C	12
D	9
E	5

Table-7: Pre operativeFrankels grade

TIME OF PRESENTATION

Time of presentation	No.of patients
Within 24 hours of injury	21
1 day to 1 week	9
1 week to 1 month	8
1month to 3 months	2

Table – 8: Time of presentation

TIME INTERVAL

Time interval from admission to surgery was 6 days to 37 days

PROCEDURE DONE

Procedure done	No.of patients
Corpectomy,bone grafting and plate fixation	11
Discectomy,bone grafting and plate fixation	29

Table- 8: procedure done

LEVEL OF FUSION

Level of fusion	No.of patients
C3C4	3
C4C5	7
C5C6	13
C6C7	5
C3C4C5	2
C4C5C6	3
C5C6C7	1
C6C7T1	1
>2 levels	5

Table- 9: Level of fusion

FOLLOW UP

X -rays were taken immediate post operative period,1 month interval for first 3 months thereafter every 3 months..

COMPLICATIONS

Totally 2 cases were expired. One case was due to pressure sore&septicaemia.One case due to aspiration pneumonitis.6patients developed bed sores in which one case developed bed sore preoperatively and others postoperatively. .

ANALYSIS OF RESULTS

Results were analysed during follow up using following criteria

1) Pain

2) Neurologic recovery

3) Fusion rate

4) Stability of spine

The neurologic status was assessed using Frankels grade

Type	Characteristics
A	Absent motor and sensory function
B	Sensation present and motor absent
C	Sensation present and motor active but not useful grade i.e<3/5
D	Sensation present and motor active and useful i.e ≥3/5
E	Normal motor and sensory function

Table-10: Frankel’s grade

The results are graded as below

GOOD

- No neck pain
- Clear fusion mass at desired level
- Good stability of spine
- Complete or partial neurologic recovery

FAIR

- Moderate neck pain which does not restrict day to day activities.
- No recovery of neurologic deficit
- Poor fusion mass
- Good stability of spine

POOR

- Severe neck pain
- No recovery or worsening of neurologic deficit
- Pseudoarthrosis
- Unstable spine

RESULTS

- In this study most of the cases were in the age group of 41-50 years.
- There was male predominance in this case
- Road traffic accident is most common mode of injury followed by fall from height
- Most of the injuries presented within 24 hours of injury
- Most of the patients presented with incomplete neurological deficit
- C5C6 subluxation with disc bulge was the most common spinal injury.
- 5 patients were operated more than 2 levels.Rest of the patients were operated at 2 levels.
- Mean duration of fusion was 15 weeks.
- Mobilisation of neck started after 6 weeks.

COMPLICATIONS

Six patients were developed pressure sore in sacral region in which one patient was managed by surgery and others treated conservatively. Two patients died in which one was due to aspiration pneumonitis and other due to septicaemia.

POST OPERATIVE FRANKELS GRADE.

Preoperative	Post operative					Total
	A	B	C	D	E	
A	-	6	2	2	2	12
B	_	_	1	_	1	2
C	_	_	_	6	7	13
D	_	_	_	_	10	10
E	_	_	_	_	4	4
Total	_	**6**	**3**	**8**	**23**	**40**

Table-11: Post operativeFrankels grade.

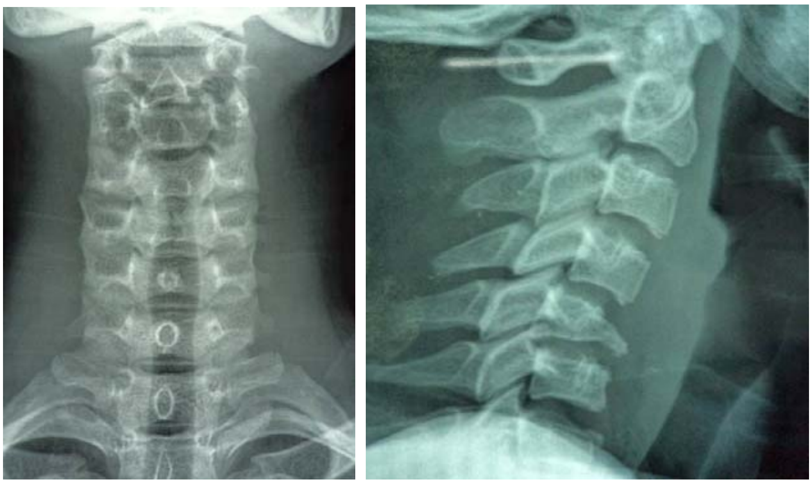
CASE ILLUSTRATIONS

CASE-1

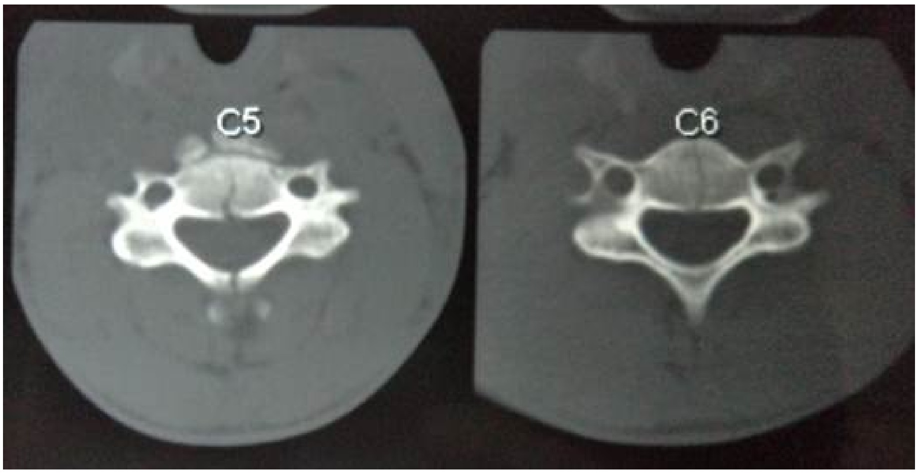
Name	:	Manikandan
Age/sex	:	19/m
Mode of injury	:	Fall from height
Preoperative Frankels grade	:	D
X-ray findings	:	C5C6 fracture
CT findings	:	C5 body and lamina fracture and C6 body fracture
MRI findings	:	C5 C6 fracture and mild cord compression at the level of C5
Procedure done	:	C5 corpectomy and anterior fusion with Locking cervical plate
Follow up	:	8 months
Post operative Frankels grade	:	E
Results	:	Good

CASE-I

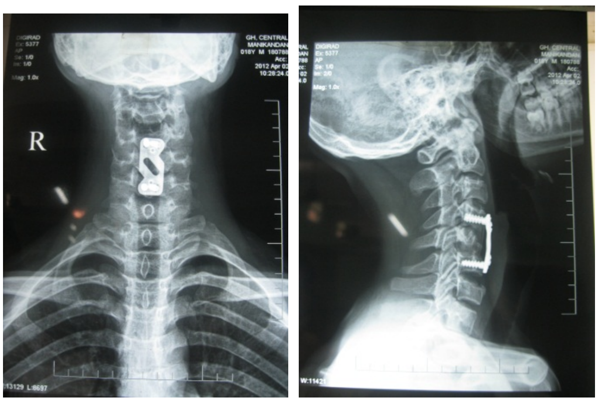
Pre Operative X-Rays



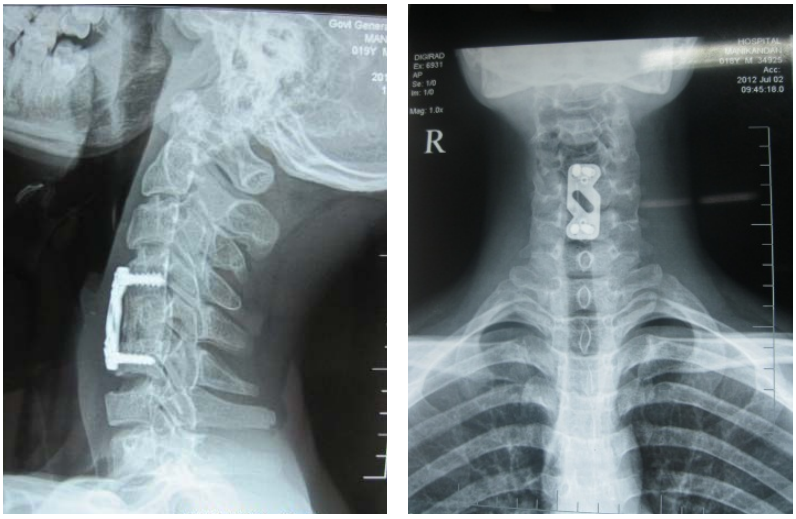
Pre OP CT Scan



Immediate Post OP X-Rays



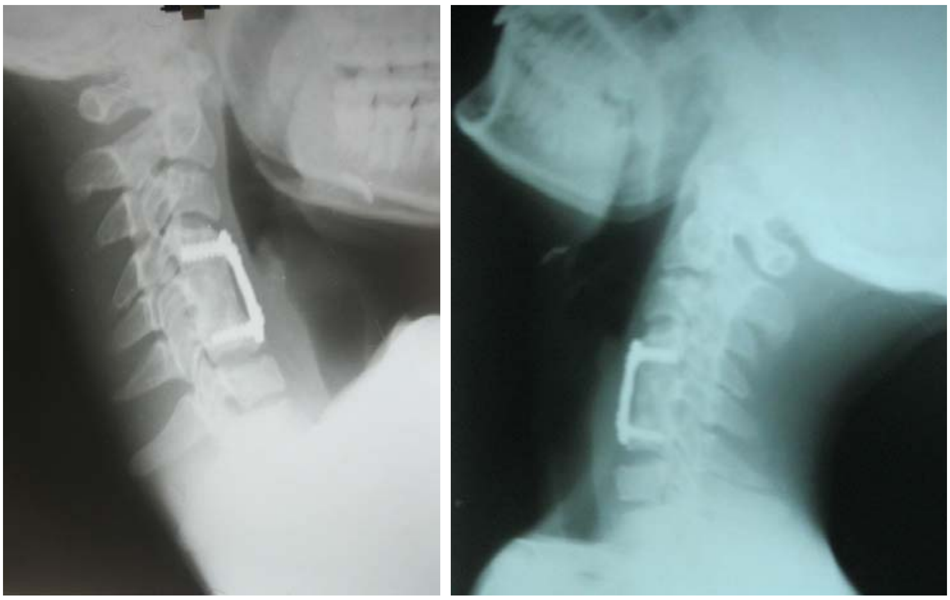
8 Months Followup X-Rays



Post Operative Clinical Photo

8 Months Followup Neck Movements

Flexion extension view

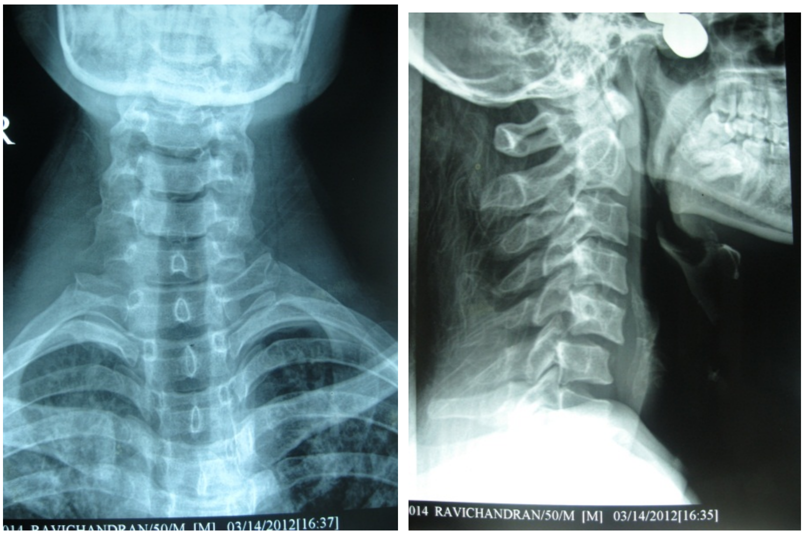


CASE- 2

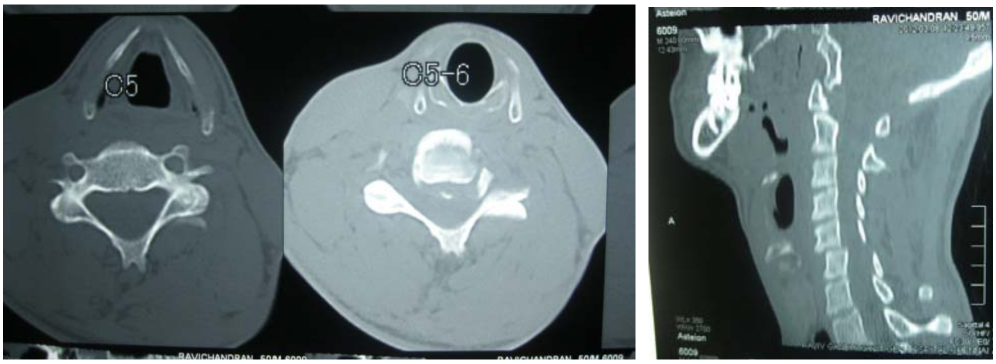
Name	:	Ravichandran
Age/sex	:	50/m
Mode of injury	:	Fall from bullock cart
Preoperative Frankels grade	:	C
X-ray findings	:	C5C6 subluxation
CT findings	:	C5C6 subluxation
MRI findings	:	C5C6 subluxation with disc prolapse
Procedure done	:	C5C6 discectomy and anterior fusion with Locking cervical plate
Follow up	:	9 months
Post operative Frankels grade	:	E
Results	:	Good

CASE-2

Pre Operative X-Ray

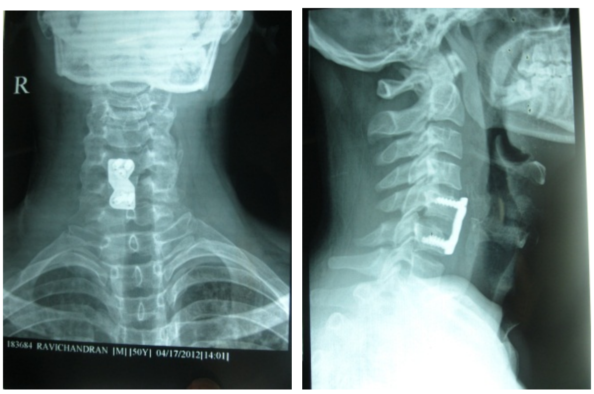


Pre OP CT Scan



Pre OP MRI

Immediate Post OP X-Rays



Follow UP X-Rays

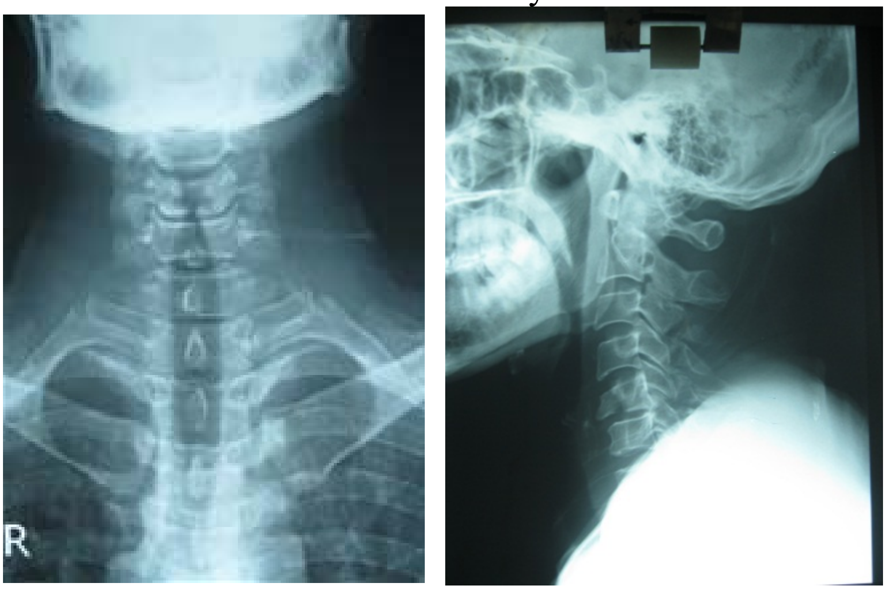
Post Op Clinical Photo

CASE-3

Name	:	Gandhi
Age/sex	:	45/m
Mode of injury	:	Fall from height
Preoperative Frankels grade	:	A
X-ray findings	:	C5C6 fracture
CT findings	:	C5C6 fracture
MRI findings	:	C5C6 fracture and cord contusion C5C6
Procedure done	:	C5 corpectomy and anterior fusion with Locking cervical plate
Follow up	:	8 months
Post operative Frankels grade	:	C
Results	:	Good

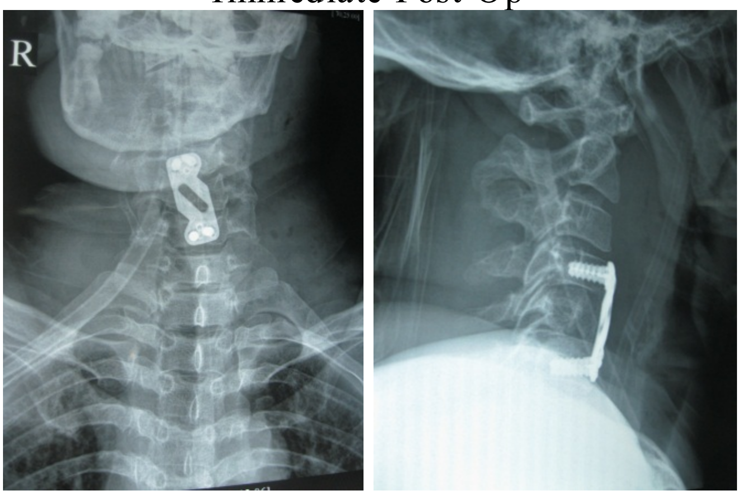
CASE-3

Pre OP X-Rays



Pre OP MRI & CT Scans

Immediate Post Op



Followup X-Rays

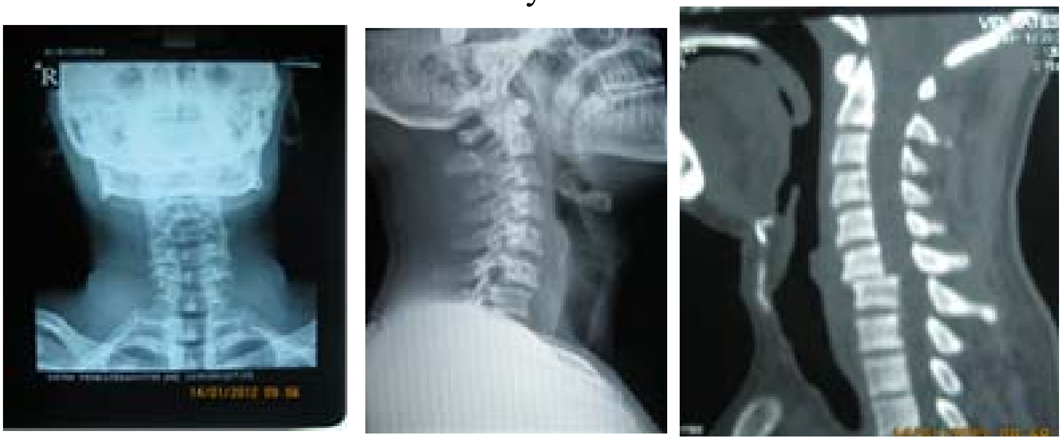
Clinical Photo

CASE-4

Name	:	Venkatesan
Age/sex	:	38 Year male
Mode of injury	:	Road traffic accident
Preoperative Frankelsgrade	:	C
X ray findings	:	C6C7 subluxation
CT findings	:	C6C7 subluxation
MRI findings	:	C6C7 subluxation with cord edema at the level of C6
Procedure done	:	C6C7 discectomy and anterior cervical fusion with Locking cervical plate.
Follow up	:	7 months
Post operative Frankelsgrade	:	D
Result	:	Good

CASE-4

Pre OP X-Rays & CT Scan



Pre OP MRI

Post OP X-Rays

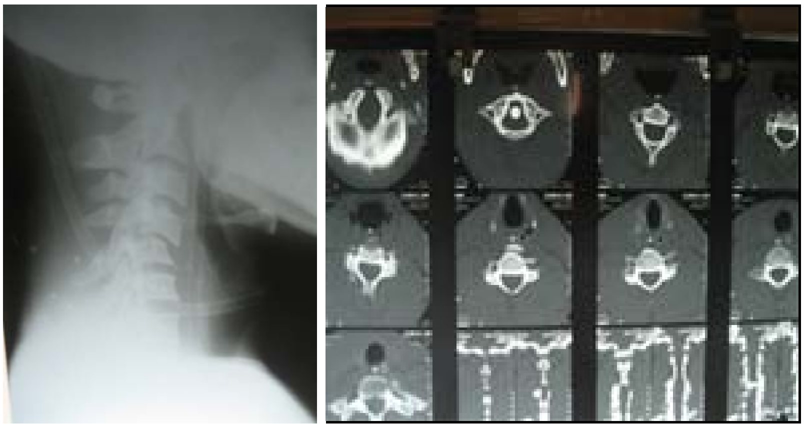
Post OP Clinical Photo

CASE-5

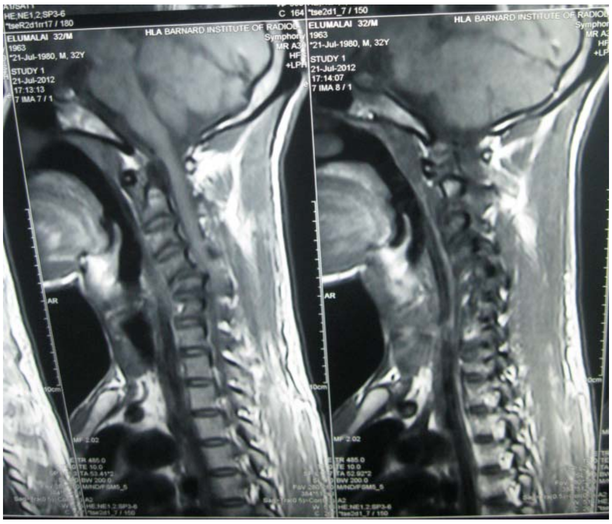
Name	:	Elumalai
Age/sex	:	32 Year male
Mode of injury	:	Road Traffic Accident
Preoperative Frankelsgrade	:	D
X ray findings	:	C4C5 subluxation
CT findings	:	C4C5 subluxation
MRI findings	:	C4C5 subluxation with C4C5 Disc prolapse &cord edema at the level of C4
Procedure done	:	C4C5 discectomy and anterior cervical fusion with Locking cervical plate.
Follow up	:	8 months
Post operative Frankelsgrade	:	E
Result	:	Good

CASE-5

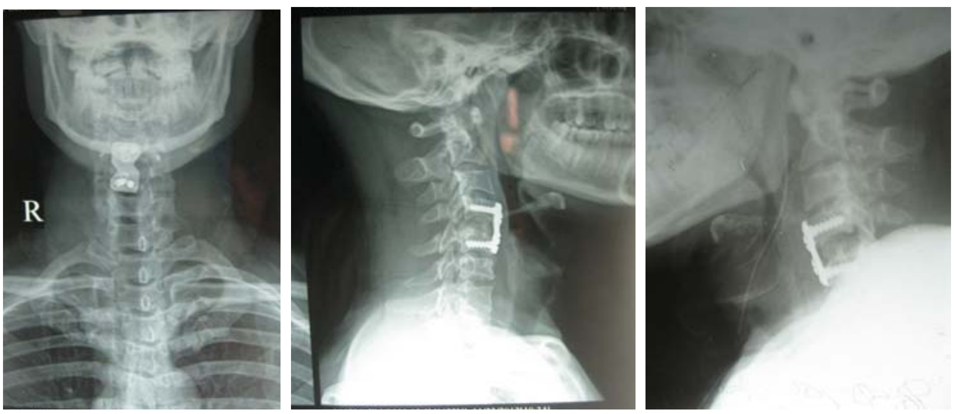
Pre Op X-Ray & CT



Pre OP MRI



Post OP Followup X-Rays

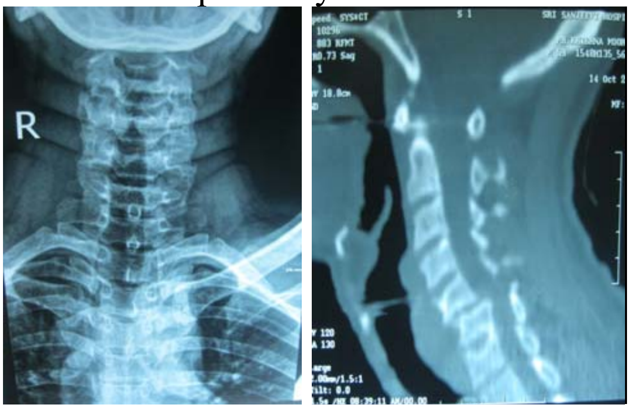


CASE-6

Name	:	Krishnamoorthy
Age/sex	:	46 Year male
Mode of injury	:	Road traffic accident
Preoperative Frankelsgrade	:	C
X ray findings	:	C5C6 subluxation
CT findings	:	C5C6 subluxation
MRI findings	:	C5C6 subluxation with cord edema at the level of C5
Procedure done	:	C5C6 discectomy and anterior cervical fusion with Locking cervical plate.
Follow up	:	8 months
Post operative Frankel's Grade	:	E
Result	:	Good

CASE-6

Pre Op X-Ray & CT Scan



Pre OP MRI

Post OP Followup X-Rays

DISCUSSION

The principal goals in the surgical treatment of cervical spine injuries are: stabilisation of the spine, decompression of the neurological elements and facilitation of rehabilitation[18] The most effective method for decompression,reconstruction and stabilisation of patients with cervical spine injuries remains controversial.Stabilisation is obtained by fusion to adjacent vertebrae, and can be done via either an anterior or posterior approach.[22]

Although many authors have reported good results with posterior approach and both anterior as well as posterior approach progressive kyphotic deformities and the halo vest related complications remain significant concerns.Since the introduction of anterior plate fixation by Orozco andLlovet-Tapies,Bohler and Tscherne*et al.* excellent clinical results have been reported in the literature.[27,28] Since then this technique has gained in popularity.Originally non-locked plates were used, with either static or dynamic screw fixation. Since then the locked plate system has been introduced,In recent years, anterior plating with locked fixation screws has been shown to provide better stability than conventional anterior plating without locked screw fixation[21]. Fogel *et al*, also showed that locking plate constructs had higher pull-out strengths than non locked systems[15].

Several investigators have conducted biomechanical studies of the surgical construct stability provided by various anterior and posterior instrumentations of the cervical spine[21,23-25]. Broadly speaking the options are anterior alone, posterior alone, or a combined stabilisation approach[28]. It has been concluded by many of these studies that combined anterior and posterior fixation, and a posterior alone fixation, are both biomechanically more stable than an anterior alone fixation. Although posterior stabilisation alone provides adequate stability, there is inadequate decompression anteriorly via a corpectomy, especially when there is canal compromise, so this technique is not favoured by surgeons[29]. Therefore this leaves two options: anterior alone stabilisation or a combined approach.

Some studies have suggested that anterior plate fixation alone was insufficient when posterior structures were injured. There have been no studies though, to assess the success of the technique of anterior alone locked plate stabilisation after single level corpectomy, with postoperative immobilisation in a rigid cervical collar. The theory behind this is that the increased stability afforded by locked plates, combined with immobilisation in a rigid cervical collar, obviates the need for posterior stabilisation.

Combined anterior and posterior approach is associated with increased complications and prolonged operative time. If an anterior alone approach shows acceptable results then it would be an attractive option due to the shorter theatre time required, reduced cost and patient morbidity.There is a paucity of literature showing results using this technique. Adams *et al* performed in vitro testing simulating burst fractures with posterior distraction of the subaxial cervical spine[33]. They then stabilised this with an anterior locked plate with graft, and showed that this technique is capable of returning the stability of this cadaveric spine to well within its pre-injury level.[33] Grubb *et al* also investigated this using an injury model with anterior and posterior disruption.[31]. They demonstrated that the stability of the normal spine was comparable to that of an injured spine stabilised by an anterior locking plate with unicortical screws, or by a non-locking plate with bicorticalscrews.[32].According to Kocis, Windsche et al surgery on lower cervical spine injuries predominantly done from anterior approach,because it is safe and effective.[36].

OUR EXPERIENCE

In our institute,for sub axial cervical spine injuries the Locking cervical plate show good results radiologically as well as neurologically as compared to non lockingplate.The complications related to non locking plate like screw pullout, plate failure is less likely occur in locking plates.The normal lordotic curve of cervical spine is maintained well in these cases compared to the patients treated with non locking plate.Duration of surgery and general anaesthesia-is 3.5 hours according to McAfee &Bohlman et al [34].In our study it has been 2.0 hours. Average blood loss in our study during the whole procedure is 150 ml.In our study intercorporal fusion has been achieved in all cases.Overall complication rate,duration of time is lesser than the combined procedure or anterior fusion with non locking plate according to DtMcGuire,N Gruger[36].we too support the same view.

CONCLUSION

1) The use of anterior cervical plating after anterior corpectomy and fusion with autologous bone graft greatly enhances arthrodesis.

2) Locking cervical plate provides rigid stabilisation

3) Therefore we consider that the Anterior decompression and fusion with locking compression plate as a viable procedure in subaxial cervical spine injuries.

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ANNEXURE - I

CONSENT FORM FOR OPERATION/ANAESTHESIA

I ____________________ Hosp. No.____________ in my full senses hereby give my complete consent for ________________ or any other procedure deemed fit which is a diagnostic procedure / biopsy / transfusion / operation to be performed on me / my son / my daughter / my ward __________ age __________ under any anaesthesia deemed fit.

The nature and risks involved in the procedure have been explained to me to my satisfaction. For academic and scientific purpose the operation/procedure may be televised or photographed.

Date :

Signature/ Thumb Impression of Patient/ Guardian

Name :
Designation:
Guardian
Relationship
Full address

ANNEXURE-II

PROFORMA

NAME:

AGE&SEX:

IP NO: UNIT: WARD:

ADDRESS:

PH NO:

DOA:

DOS:

DOD:

MODE OF INJURY:

GENERAL EXAMINATION:

OTHER SYSTEMIC EXAMINATIONS:

NEUROLOGICAL EXAMINATION:

NEUROLOGICAL GRADE(FRANKELS):

WHITE&PUNJABI INSTABILTY SCORE:

X-RAY CERVICAL SPINE:

CT CERVICAL SPINE:

MRI CERVICAL SPINE:

TREATMENT:

ANAESTHESIA:

POSITION:

APPROACH:

INTRA OP FINDINGS:

IMPLANT USED:

INTRA OP COMPLICATIONS:

BLOOD LOSS:

NO OF UNITS BLOOD TRANSFUSED:

DURATION:

POST OP NEUROLOGY(Frankels grade):

POST OP X-RAY:

CONDITION ON DISCHARGE:

FOLLOW UP

1.

2.

3.

ANNEXURE-IV ASIA SCALE

Patient Name ______________________________

Examiner Name ______________________________ Date/Time of Exam ____________________

ASIA — AMERICAN SPINAL INJURY ASSOCIATION

STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

ISCoS

MOTOR

KEY MUSCLES (scoring on reverse side)

	R	L	
C5			Elbow flexors
C6			Wrist extensors
C7			Elbow extensors
C8			Finger flexors (distal phalanx of middle finger)
T1			Finger abductors (little finger)

UPPER LIMB TOTAL (MAXIMUM): ☐ (25) + ☐ (25) = ☐ (50)

Comments:

	R	L	
L2			Hip flexors
L3			Knee extensors
L4			Ankle dorsiflexors
L5			Long toe extensors
S1			Ankle plantar flexors

Voluntary anal contraction (Yes/No) ☐

LOWER LIMB TOTAL (MAXIMUM): ☐ (25) + ☐ (25) = ☐ (50)

SENSORY

KEY SENSORY POINTS

	LIGHT TOUCH R	LIGHT TOUCH L	PIN PRICK R	PIN PRICK L
C2				
C3				
C4				
C5				
C6				
C7				
C8				
T1				
T2				
T3				
T4				
T5				
T6				
T7				
T8				
T9				
T10				
T11				
T12				
L1				
L2				
L3				
L4				
L5				
S1				
S2				
S3				
S4-5				

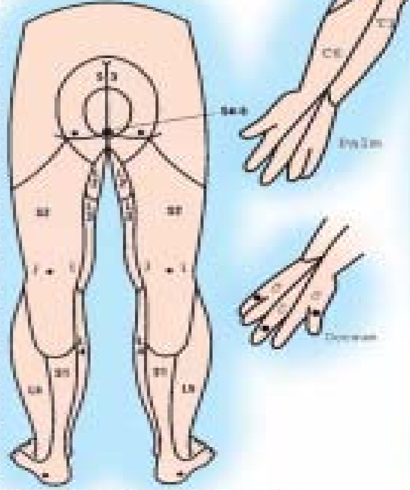
0 = absent
1 = impaired
2 = normal
NT = not testable

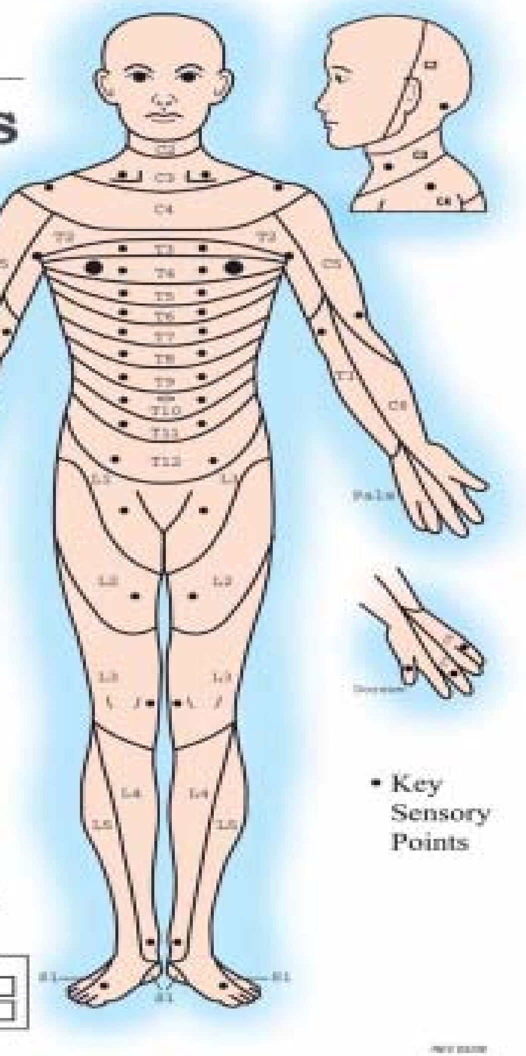
Any anal sensation (Yes/No) ☐

TOTALS ☐ + ☐ (MAXIMUM) (56) (56) (56) (56)

PIN PRICK SCORE (max: 112)

LIGHT TOUCH SCORE (max: 112)





NEUROLOGICAL LEVEL (The most caudal segment with normal function)		R	L	COMPLETE OR INCOMPLETE? (Incomplete = Any sensory or motor function in S4-S5) ☐	ZONE OF PARTIAL PRESERVATION (Caudal extent of partially innervated segments)		R	L
	SENSORY					SENSORY		
	MOTOR			ASIA IMPAIRMENT SCALE ☐		MOTOR		

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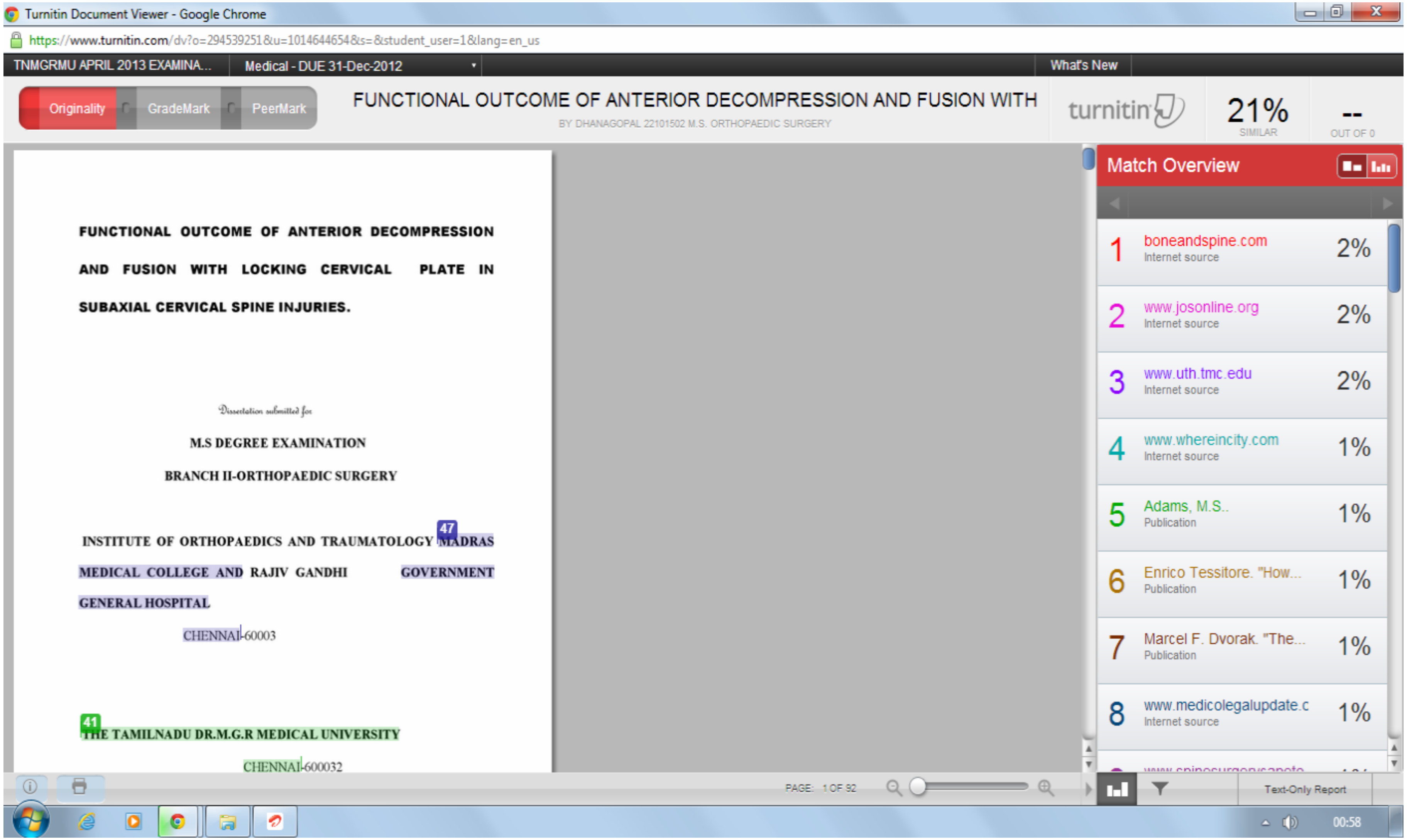
A



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Dissertation submitted for

M.S DEGREE EXAMINATION

BRANCH II-ORTHOPAEDIC SURGERY

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Text-Only Report

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ANNEXURE - III

MASTER CHART

S NO.	NAME	AGE&SEX	IP NO.	MODE OF INJURY	DIAGNOSIS	CLASSIFICATION – ALLEN FERGUESON	PROCEDURE	COMPLICATION	FOLLOW UP MONTHS	PREOP FRANKELS GRADE	POST OP FRANKELS GRADE	OUTCOME (FUSION)
1	VENKATESAN	38/M	10233	ROAD TRAFFIC ACCIDENT	C6C7 SUBLUXATION	COMPRESSIVE FLEXION	C6C7 DISCECTOMY&LOCKING CERVICAL PLATE	NIL	7	C	D	+
2	MANIKANDAN	19/M	10899	FALLFROM HEIGHT	C5C6 FRACTURE	VERTICAL COMPRESSION STAGE III	C5 CORPECTOMY&ANT STABILISATION	NIL	8	D	E	+
3	GANDHI	45/M	29987	FALLFROM HEIGHT	C5C6 FRACTURE	VERTICAL COMPRESSION STAGE II	C5 CORPECTOMY&ANT STABILISATION	NIL	8	A	C	+
4	MUTHU	50/M	28766	FALLOF HEAVY WEIGHT OVERHEAD	C5 FRACTURE	VERTICAL COMPRESSION STAGE III	C5 CORPECTOMY&ANT STABILISATION	NIL	9	A	C	+
5	RAVICHANDRAN	50/M	31167	FALLFROM BULLOCK CART	C5C6 SUBLUXATION	FLEXION DISTRACTION STAGE I	C5C6 DISCECTOMY&ANT STABILISATION	NIL	9	E	E	+
6	MOHAN	21/M	55659	ROAD TRAFFIC ACCIDENT	C5 BODY FRACTURE WITH LAMINA FRACTURE	DISTRACTIVE FLEXION STAGE II	C5C6 DISCECTOMY ANTERIOR STABILISATION	NIL	9	A	B	+
7	ELLAPPAN	56/M	5482	FALLON LEVEL GROUND	TRAUMATIC DISC PROLAPSE C3C4,C4C5		C3C4,C4C5 DISCECTOMY ANTERIOR STABILIOSDATION	NIL	6	D	E	+
8	BALU	23/M	5324	FALLFROM HEIGHT	C6C7 SUBLUXATION	FLEXTION DISTRACTION	C6C7 DISCECTOMY ANTERIOR STABILISATION	NIL	9	C	D	+
9	KERSON	19/M	54747	SEA DIVING	C6C7 FRACTURE SUBLUXATION	VERTICAL COMPRESSION STAGE III	C6CORPECTOMY ANTERIOR STABILISATION	GRADE II SACRAL SORE	8	A	B	+
10	RAJASEKAR	19/M	29069	ROAD TRAFFIC ACCIDENT	C3C4 SUBLUXATION	DISTRACTIVE FLEXION STAGE I	ANTERIOR STABILISATION	NIL	9	E	E	+

11	MANI	45/M	2341	ROAD TRAFFIC ACCIDENT	C5C6 SUBLUXATION	COMPRESSIVE FLEXION STAGE II	C5C6 DISCECTOMY ANTERIOR STABILISATION	DIED AFTER 7 MONTHS DUE TO SEPTICAEMIA		A		+
12	NANDHIKESAVAN	54/M	53343	FALL ON LEVEL GROUND	TRAUMATIC CERVICAL MYELOPATHY OF C5C6		C5 CORPECTOMY ANTERIOR STABILISATION	NIL	6	C	E	+
13	PERIYANNAN	32/M	51910	ROAD TRAFFIC ACCIDENT	C4 C5 BODY AND LAMINA FRACTURE	VERTICAL COMPRESSION STAGE III	C4C5 CORPECTOMY AND ANTERIOR CERVICAL PLATING	DIED AFTER 5 MONTHS		A	-	-
14	MURUGAN	30/M	48805	FALL FROM HEIGHT	C5C6 TRAUMATIC DISC PROLAPSE		C5C6 DISCECTOMY ANTERIOR STABILISATION	NIL	9	C	E	+
15	ANTONY	35/M	84770	ROAD TRAFFIC ACCIDENT	C7 BODYFRACTURE	VERTICAL COMPRESSION STAGE III	C7 CORPECTOMY ASNTERIOR STABILISATION	NIL	9	A	B	+
16	ARUMUGAM	45/M	65386	SLIP AND FALL WITH WEIGHT ON HEAD	C6C7 SUBLUXATION WITH DISC PROLAPSE	DISTRACTIVE FLEXION STAGE I	C7C6C7 DISCECTOMY ANTERIOR STABILISATION AND FUSION	GRADI I SACRAL SORE	9	A	C	+
17	DEVIKA	32/F	22755	ROAD TRAFFIC ACCIDENT	C5C6 TRAUMATIC DISC PROLAPSE		C5C6 DISCECTOMY AND ANTERIOR STABILISATION	NIL	9	D	E	+
18	ELLAPPAN	56/M	54823	FALL FROM HEIGHT	C4C5 TRAUMATIC DISC PROLAPSE		C4C5 DISCECTOMY	NIL	9	E	E	+
19	ELUMALAI	32/M	66035	ROAD TRAFFIC ACCIDENT	C4C5 SUBLUXATION	DISTRACTIVE FLEXION STAGE III	`C4C5 DISCECTOMY AND ANTERIOR STABILISATION	GRADE I SACRAL SORE DEVELOPED	9	C	C	+
20	GAJAPATHY	27/M	81712	FALL FROM HEIGHT	C5C6 SUBLUXATION WITH DISC BULGE	DISTRACTIVE FLEXION STAGE I	C5C6 DISCECTOMY ANTERIOR STABILISATION		12	D	E	+
21	KANNAGI	28/F	66854	ROAD TRAFFIC ACCIDENT	C6 BODY FRACTURE	VERTICAL COMPRESSION STAGE III	C6 CORPECTOMY AND ANTERIOR STABILISATION	GRADE II SACRAL SORE DEVELOPED	10	A	D	+
22	KRISHNAMOORTHY	46/M	97203	ROAD TRAFFIC ACCIDENT	C5C6 SUBLUXATION	DISTRACTIVE FLEXION STAGE I	C5C6 DISCECTOMY AND ANTERIOR STABILISATION	NIL	7	C	D	+
23	NALLENDRAN	45/M	74665	FALL FROM BICYCLE	C5C6 TRAUMATIC DISC BULGE		C5C6 DISCECTOMY ANTERIOR STABILISATION	NIL	8	C	D	+
24	PRATAP	34/M	56442	FALL OF HEAVY WEIGHT OVERHEAD	C5 BODY FRACTURE	VERTICAL COMPRESSION STAGE II	C5 CORPECTOMY AND ANTERIOR STABILISATION	NIL	9	D	E	+
25	RAJASEKAR	19/M	29669	FALL OF HEAVY WEIGHT	C3C4 SUBLUXATION	DISTRACTIVE FLEXION STAGE II	C3C4 DISCECTOMY ANTERIOR SATBILISATION	NIL	9	C	D	+

26	SENTHIL KUMAR	45/M	81729	FALL FOR BULLOCK CART	C5C6 TRAUMATIC DISC PROLAPSE		C5C6 DISCECTOMY AND ANTERIOR STABILISATION	NIL	10	D	E	+
27	SRINIVASAN	41/M	8225	ROAD TRAFFIC ACCIDENT	C5C6 SUBLUXATION	COMPRESSIVE FLEXION STAGE II	C5C6 DISCECTOMY ANTERIOR STABILISATION	GRADE IISACRAL SORE DEVELOPED AFTER 3 MONTHES	9	A	B	+
28	VEERAPANDIYAN	26/M	54697	FALL FROM HEIGHT	C5C6 SUBLUXATION	DISTRACTIVE FLEXION STAGE IV	C5C6 DISCECTOMY ANTERIOR STABILISATION	NIL	7	A	B	+
29	VENKATESH	43/M	53881	ROAD TRAFFIC ACCIDENT	C4 BODY AND LAMINAFRACTURE	VERTICAL COMPRESSION STAGE II	C4 CORPECTOMY ANTERIOR STABILISATION	NIL	9	C	D	+
30	BALAMURUGAN	35/M	85997	FALL FROM HEIGHT	C6C7 SUBLUXATION W	COMPRESSIVE FLEXION STAGE IV	C6 CORPECTOMY AND ANTERIOR STABILISATION	NIL	9	A	C	+
31	HAZARATHIYA	55/M	88472	ROAD TRAFFIC ACCIDENT	C4C5 SUBLUXATION	DISTRACTIVE FLEXION STAGE I	C4C5 DISCECTOMY AND ANTERIOR STABILISATION	NIL	11	B	D	+
32	INDRANI	45/F	87939	ROAD TRAFFIC ACCIDENT	C5C6 SUBLUXATION	DISTRACTIVE FLEXION STAGE III	C5C6 DSCECTOMY ANTERIOR STABILISATION	NIL	6	D	E	+
33	MANI	55/M	81728	FALL FROM HEIGHT	C3C4 TRAUMATIC DISC PROLAPSE		C3C4 DISCECTOMY ANTERIOR SATBILISATION	NIL	7	D	E	+
34	SUBRAMANI	54/M	72099	ROAD TRAFFIC ACCIDENT	C5C6 SUBLUXATION	COMPRESSIVE FLEXION STAGE I	C5C6 DISCECTOMY ANTERIOR STABILISATION	NIL	9	E	E	+
35	THIRUMALAI	46/M	47455	FALL FROM HEIGHT	C4 BODYFRACTURE	VERTICAL COMPRESSION STAGE II	C4 CORPECTOMY AND ANTERIOR STABILISATION	NIL	9	D	E	+
36	VELU	35/M	75032	ROAD TRAFFIC ACCIDENT	C4C5 SUBLUXATION	DISTRACTIVE FLEXION STAGE II	C4C5 DISCECTOMY AND ANTERIOR STABILISATION	NIL	10	C	E	+
37	BALU	29/M	67112	ROAD TRAFFIC ACCIDENT	C5 BODY FRACTURE	VERTICAL COMPRESSION STAGE I	C5 CORPECTOMY AND ANTERIOR STABILISATION	NIL	7	C	D	+
38	SAROJA	37/F	28879	FALL OF HEAVY WEIGHT OVERHEAD	C4C5 SUBLUXATION	COMPRESSIVE FLEXION STAGE I	C4C5 DISCECTOMY AND ANTERIOR STABILISATION	NIL	9	B	D	+
39	RAJAN	60/M	33292	ROAD TRAFFIC ACCIDENT	C5BODY AND LAMINA FRACTURE	VERTICAL COMPRESSION STAGE II	C5 CORPECTOMY ANTERIOR STABILISATION	GRADE II SACRAL SORE DEVELOPED	8	C	D	+
40	JAYA	45/F	44176	FALL FROM HEIGHT	C5C6 TRAUMATIC DISC PROLAPSE		C5C6 DISCECTOMY ANTERIOR STABILISATION	NIL	9	D	E	+